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Beyerl et al.

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(54) **ELECTRIC MOTOR FOR A POWER TOOL**

(71) Applicant: **MILWAUKEE ELECTRIC TOOL CORPORATION**, Brookfield, WI (US)

(72) Inventors: **Andrew T. Beyerl**, Pewaukee, WI (US); **Derek J. Schwab**, Glendale, WI (US); **Samantha L. Billetdeaux**, New Berlin, WI (US); **Kyle Greunke**, Milwaukee, WI (US); **Hans T. Banholzer**, Milwaukee, WI (US); **Carmen J. Castanos**, Milwaukee, WI (US)

(73) Assignee: **MILWAUKEE ELECTRIC TOOL CORPORATION**, Brookfield, WI (US)

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(51) **Int. Cl.**
H02K 1/18 (2006.01)
H02K 5/16 (2006.01)
(Continued)

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CPC ***H02K 1/185*** (2013.01); ***B25F 5/008*** (2013.01); ***H02K 5/161*** (2013.01); ***H02K 7/083*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H02K 1/185; H02K 11/33; H02K 9/227; H02K 7/083; H02K 21/16
(Continued)

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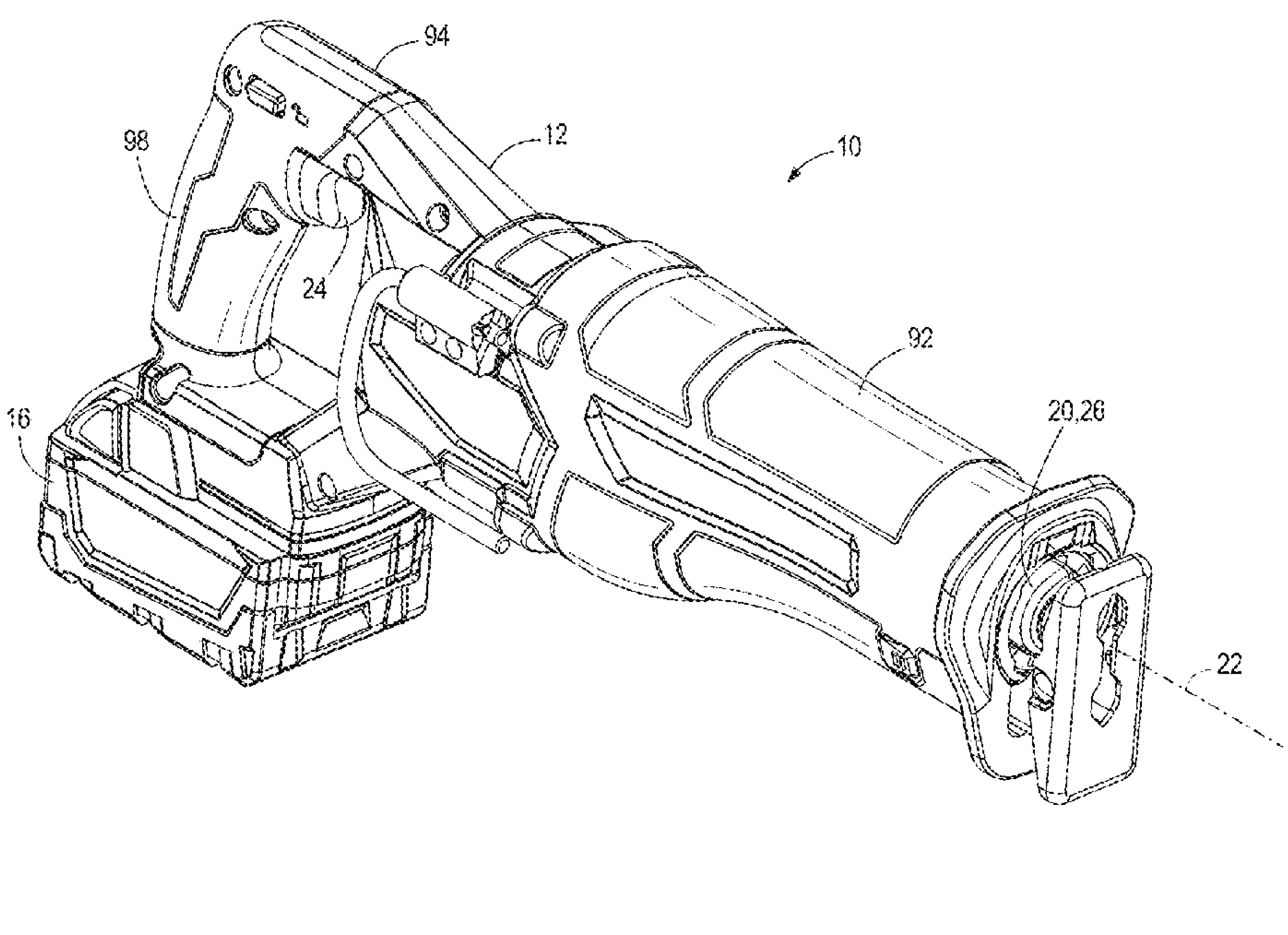
Primary Examiner — Jose A Gonzalez Quinones
(74) *Attorney, Agent, or Firm* — Michael Best & Friedrich LLP

(57) **ABSTRACT**

A power tool includes a housing having a rear wall, a motor assembly coupled to the rear wall, and a plurality of mounting legs projecting from the rear wall toward the motor assembly. The motor assembly defines a motor axis, and includes a stator assembly defining a plurality of axially extending mounting apertures. Each mounting leg defines a threaded boss corresponding to a respective mounting aperture of the stator assembly, and each threaded boss is configured to receive a threaded fastener. The mounting legs are angularly spaced at unequal intervals about the motor axis.

28 Claims, 19 Drawing Sheets



(51) **Int. Cl.**

H02K 7/08	(2006.01)
H02K 7/14	(2006.01)
H02K 11/33	(2016.01)
H02K 21/16	(2006.01)
H02K 9/22	(2006.01)
B25F 5/00	(2006.01)
B23D 51/16	(2006.01)

(52) **U.S. Cl.**
CPC ***H02K 7/145*** (2013.01); ***H02K 9/227*** (2021.01); ***H02K 11/33*** (2016.01); ***H02K 21/16*** (2013.01); *B23D 51/16* (2013.01); *H02K 2211/03* (2013.01)

(58) **Field of Classification Search**
USPC 310/50, 216.049
See application file for complete search history.

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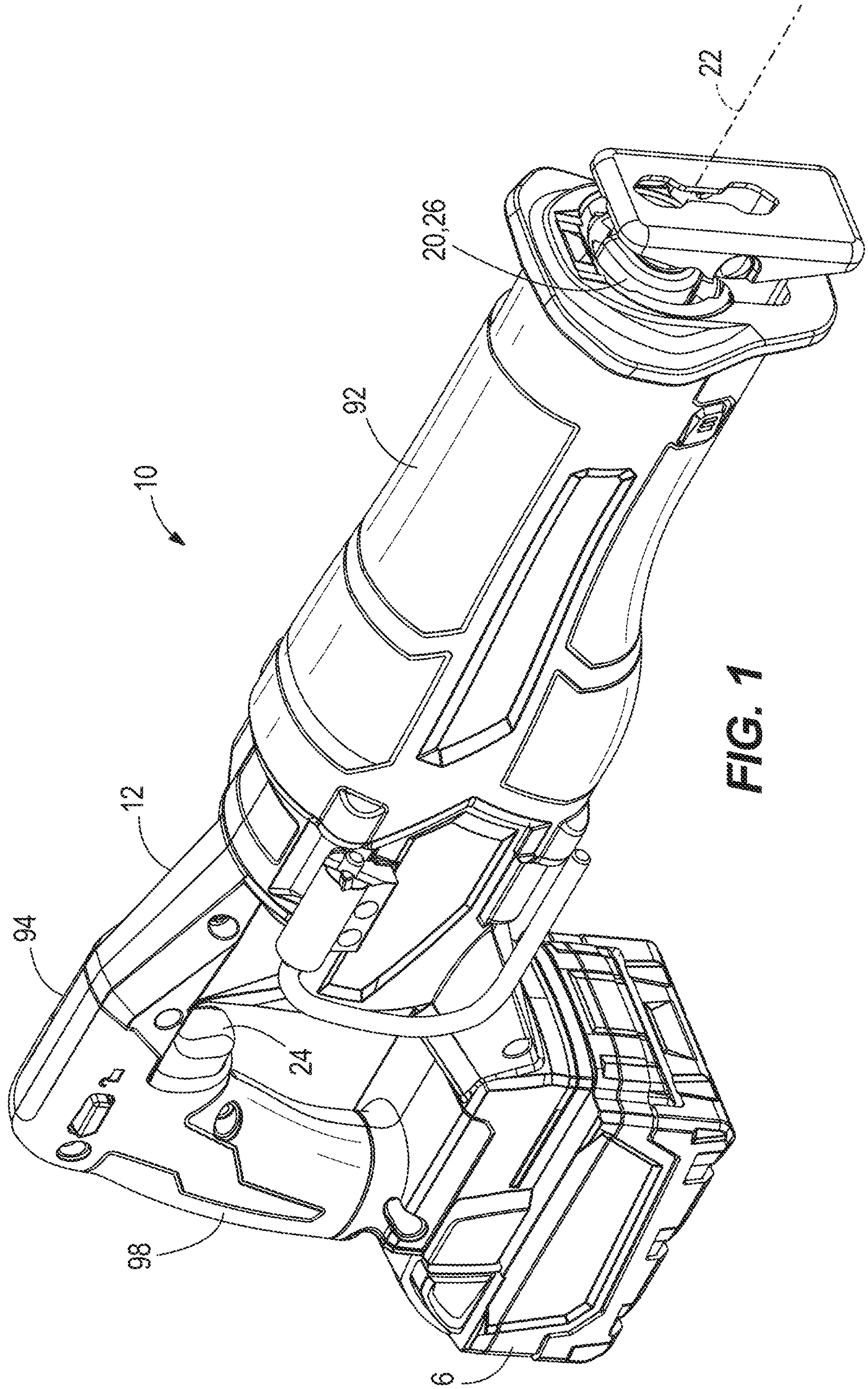

FIG. 1

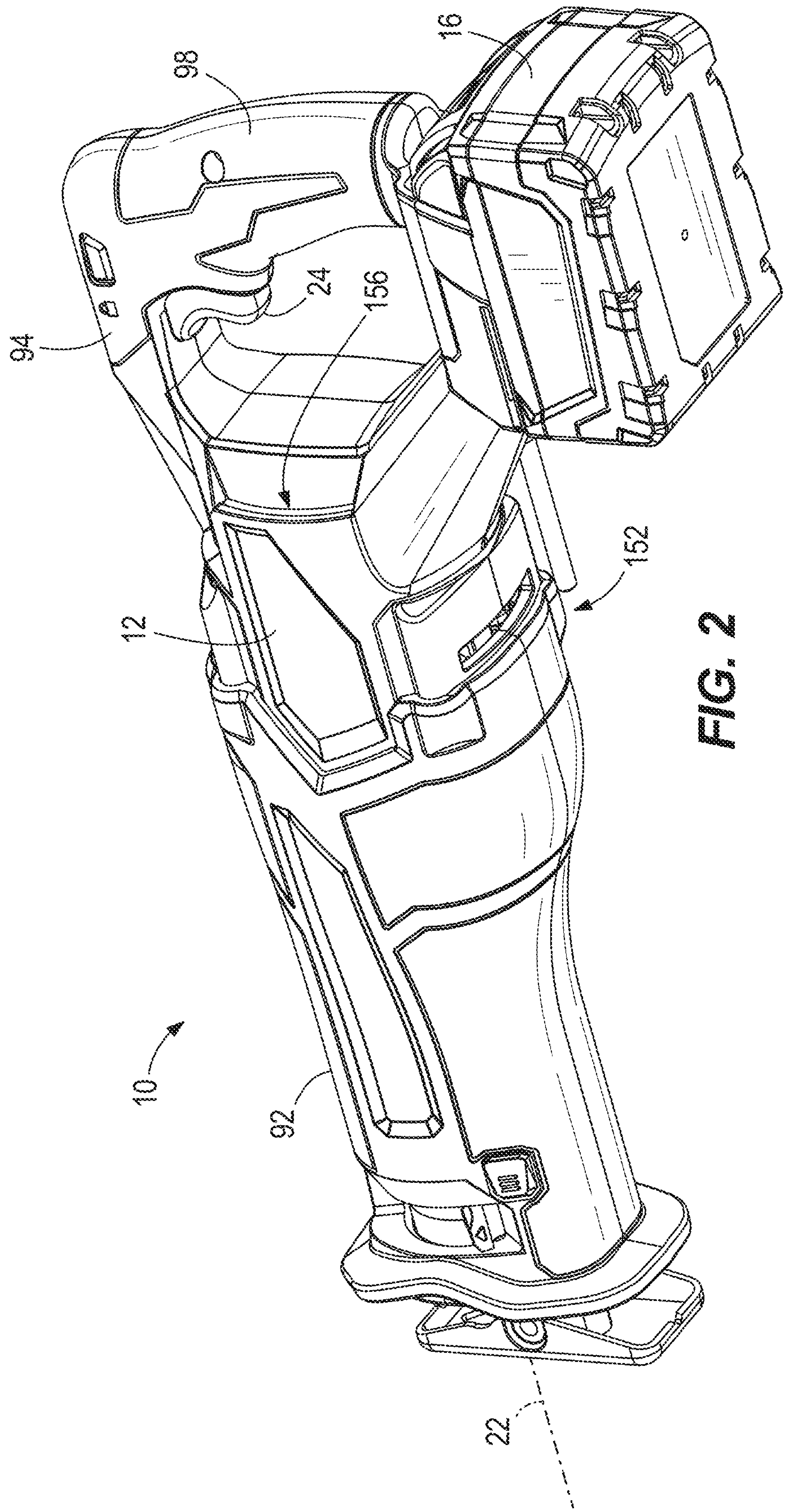

FIG. 2

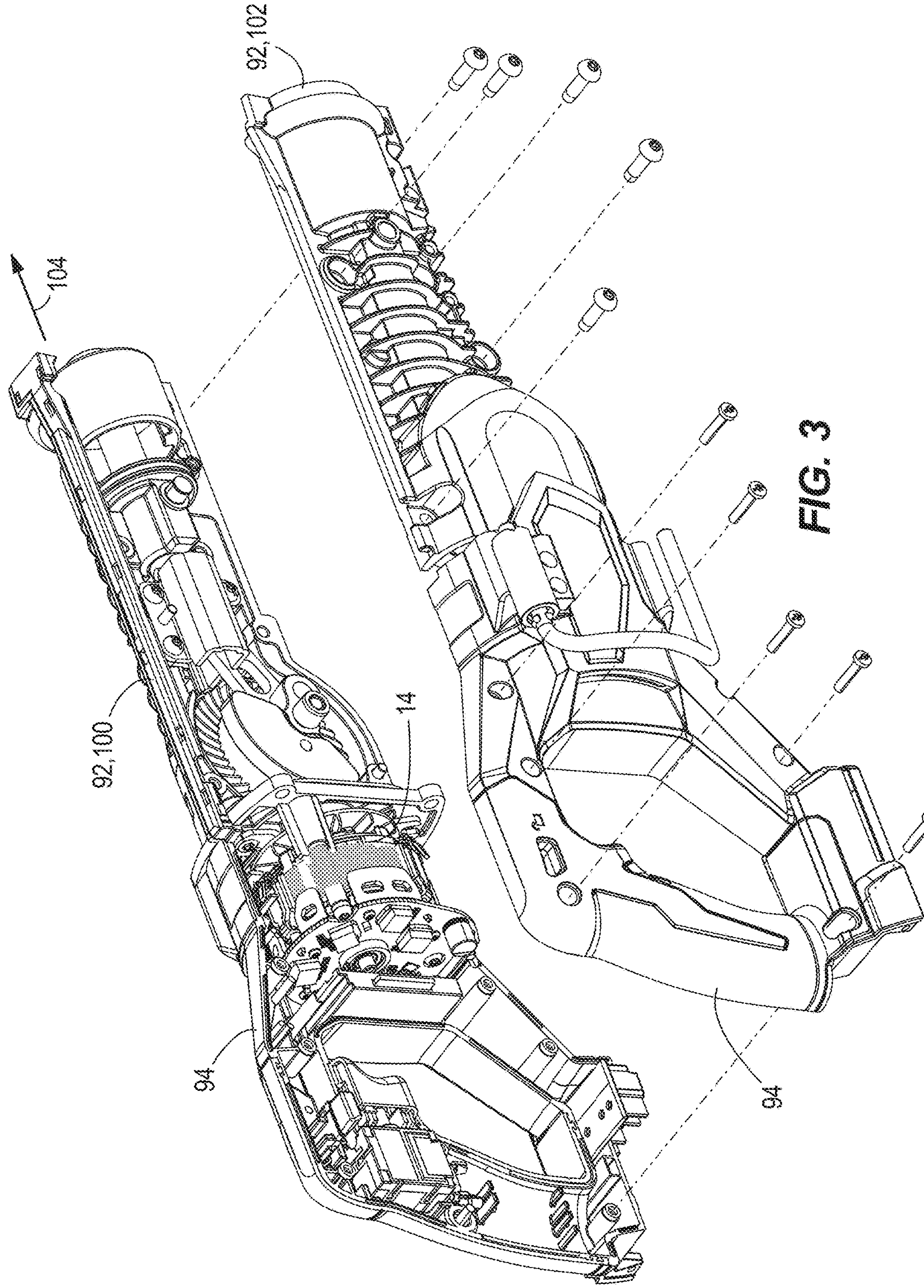

FIG. 3

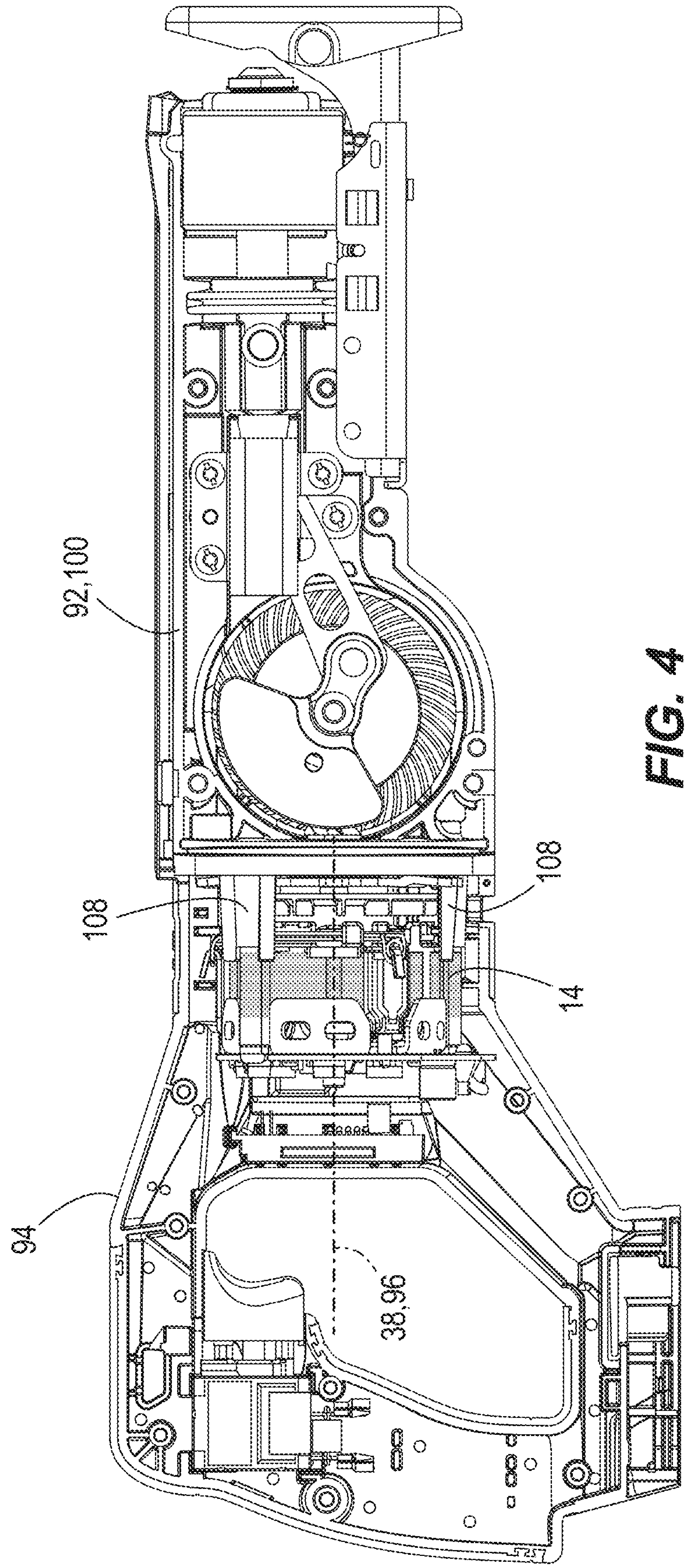

FIG. 4

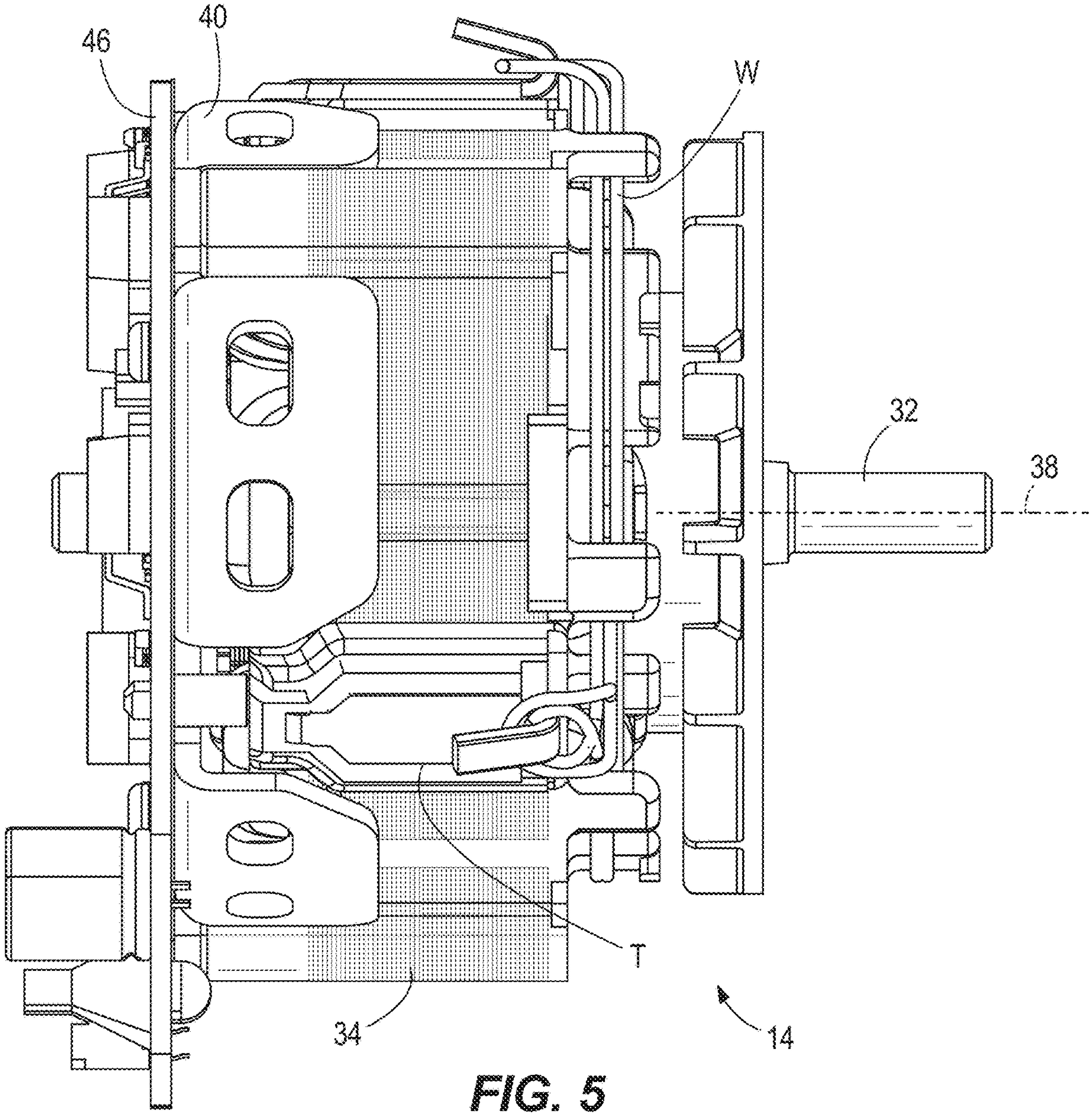

FIG. 5

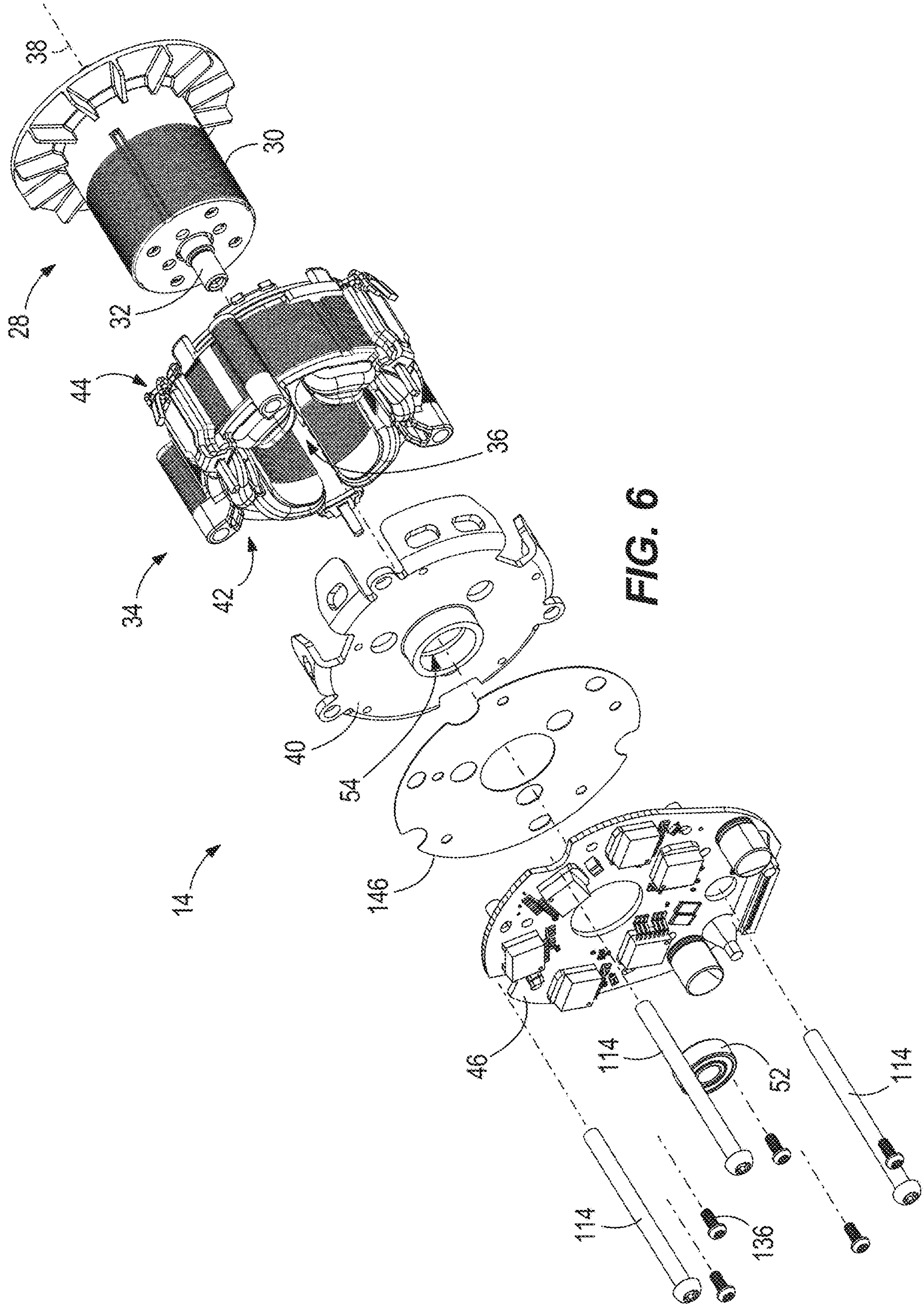

FIG. 6

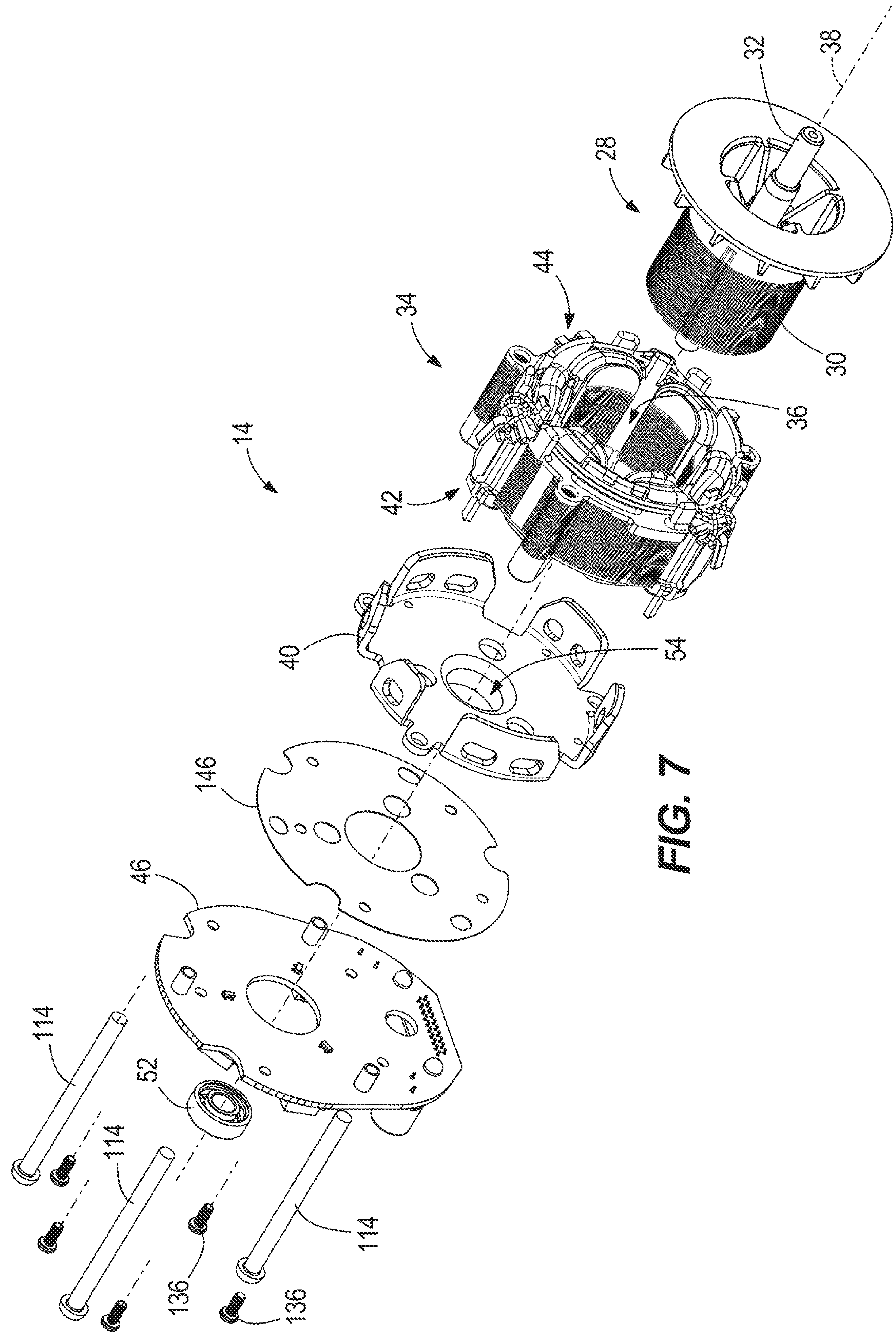

FIG. 7

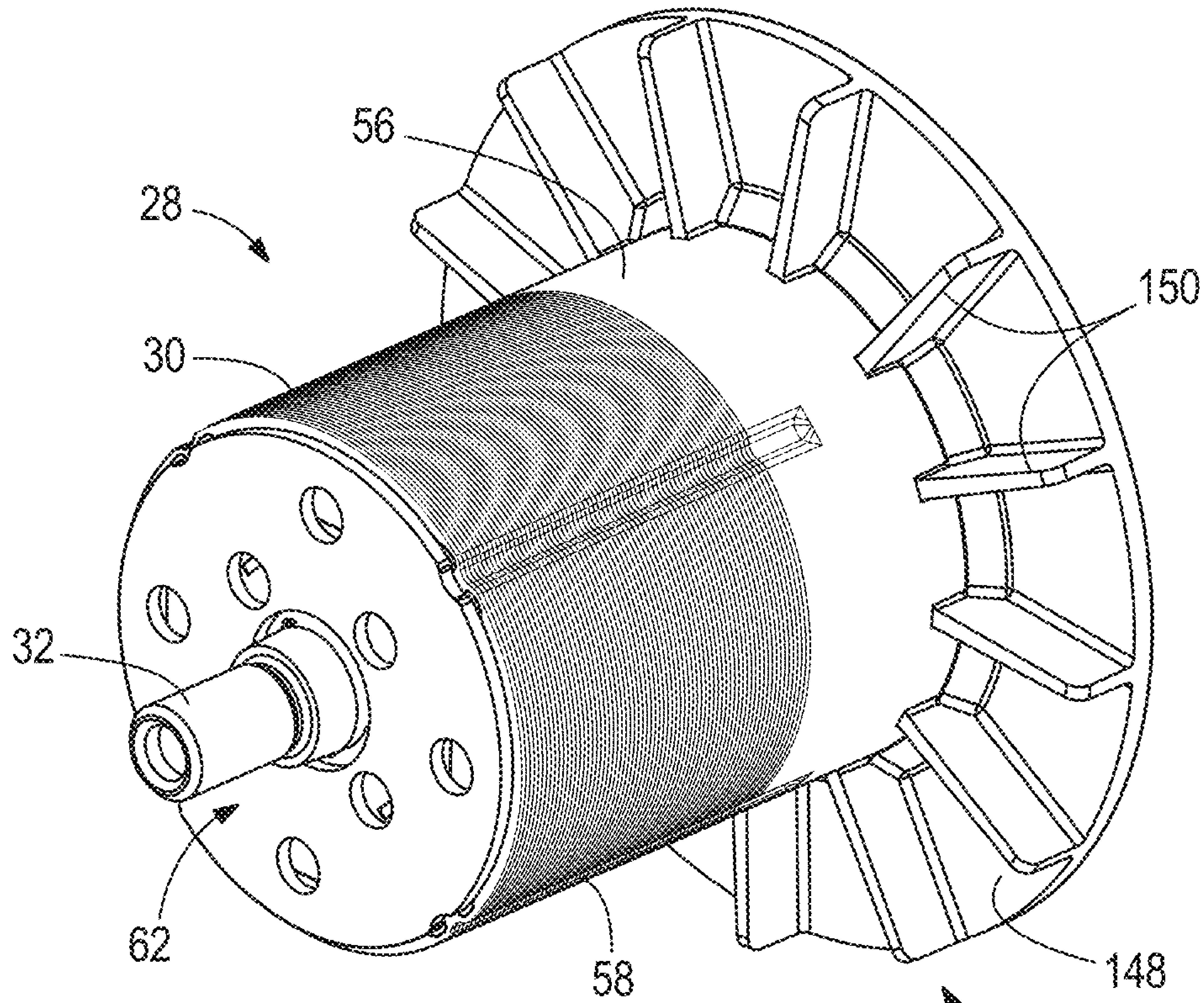

FIG. 8

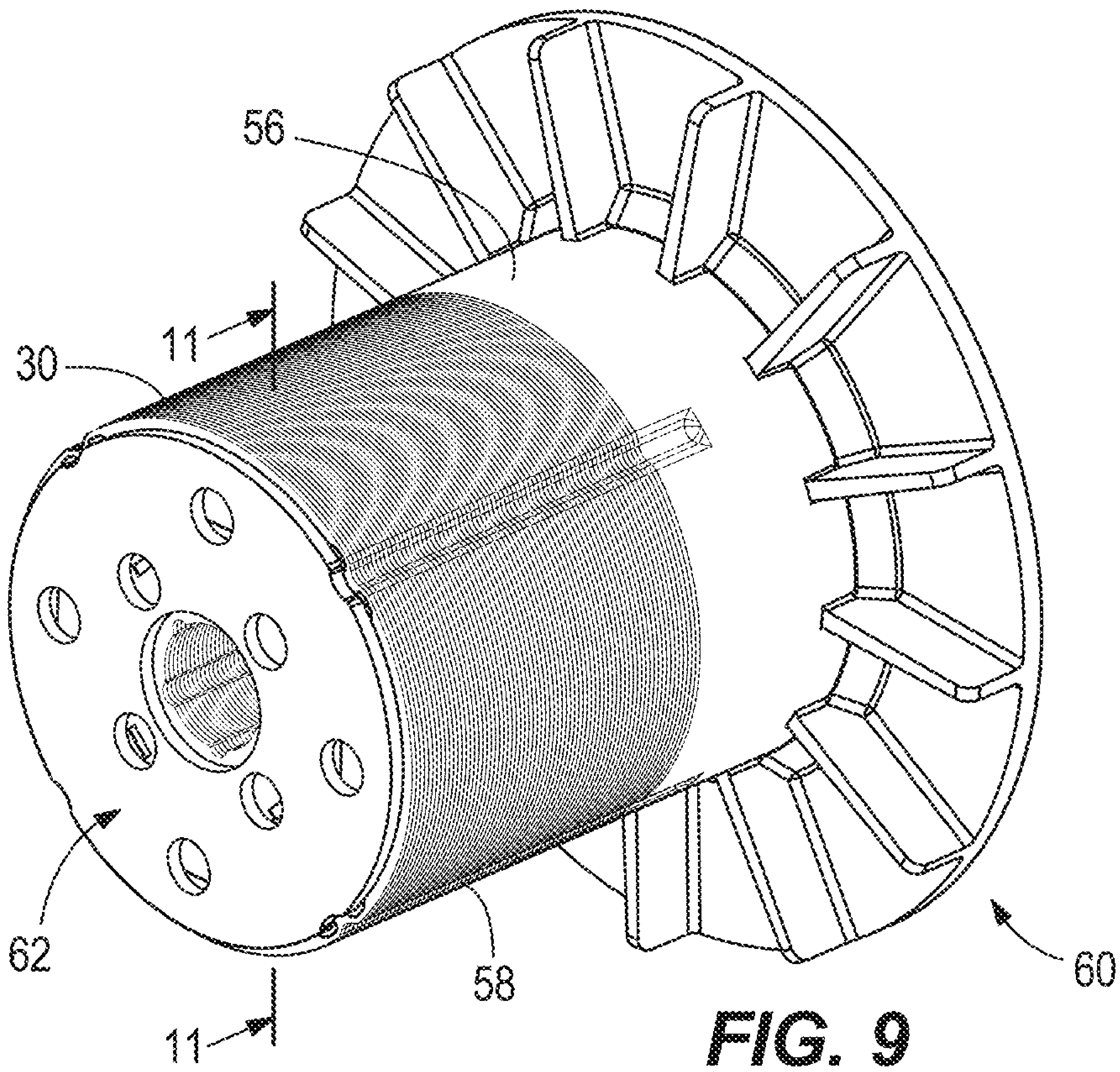

FIG. 9

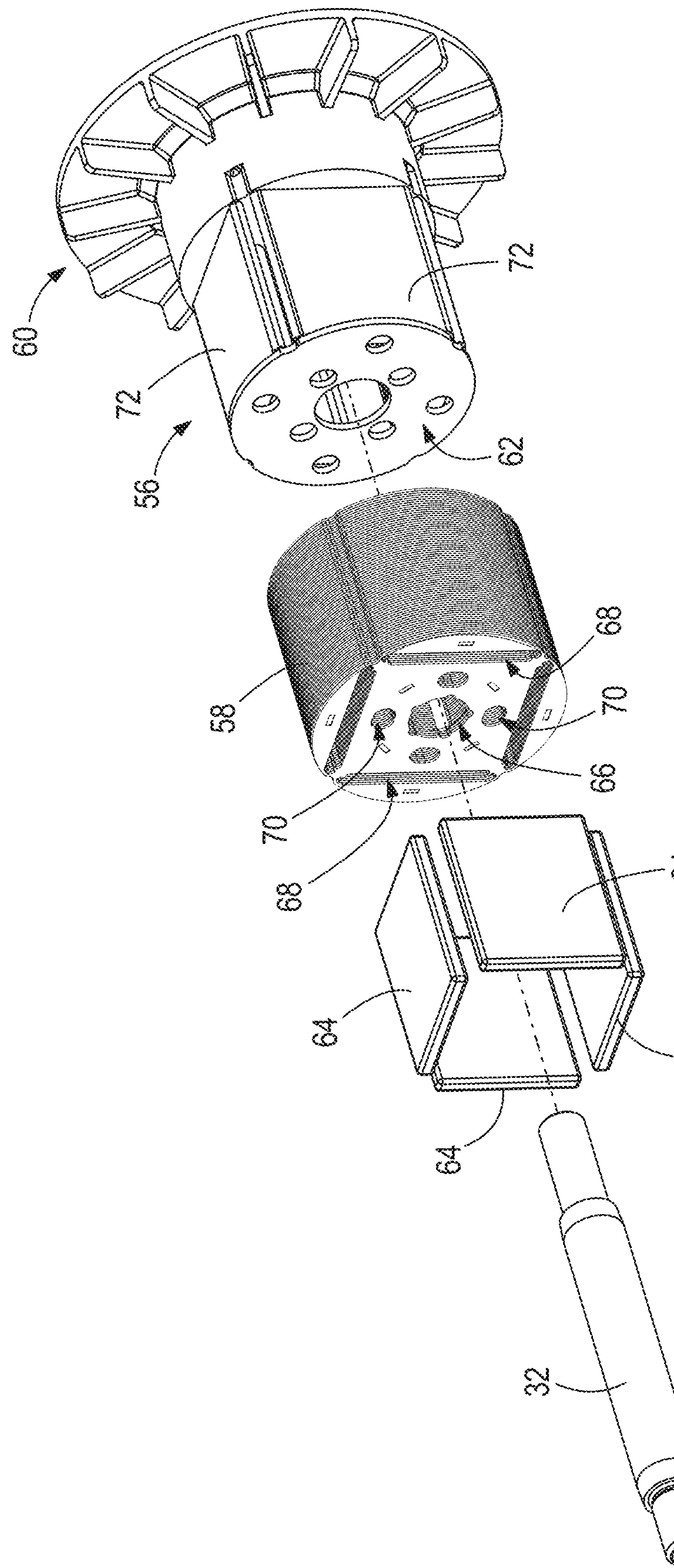

FIG. 10

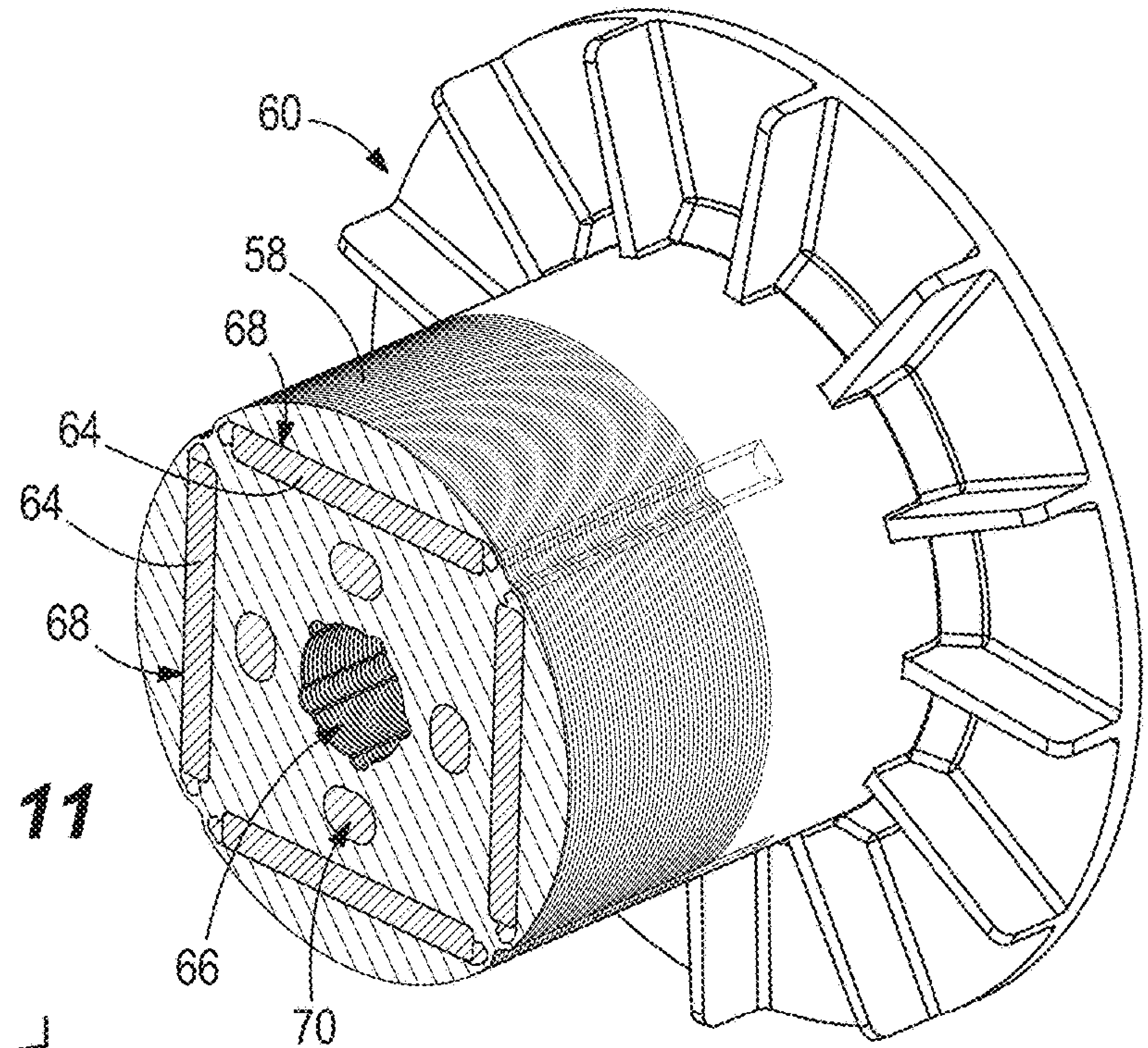
60
58
68
64
64
68
66
70

FIG. 11

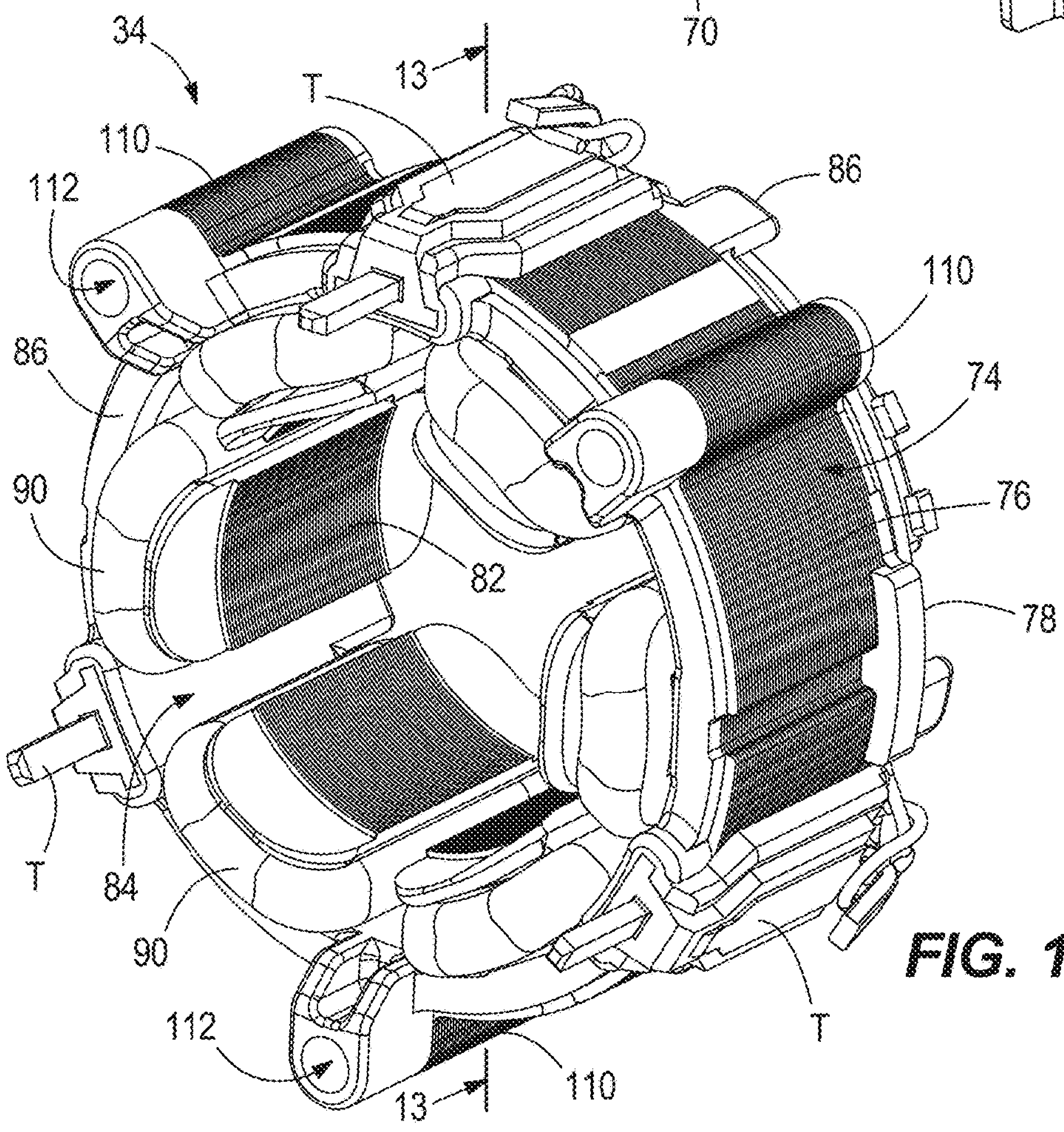
34
13
T
110
112
86
110
86
74
90
76
82
78
T
84
90
112
110
13
T

FIG. 12

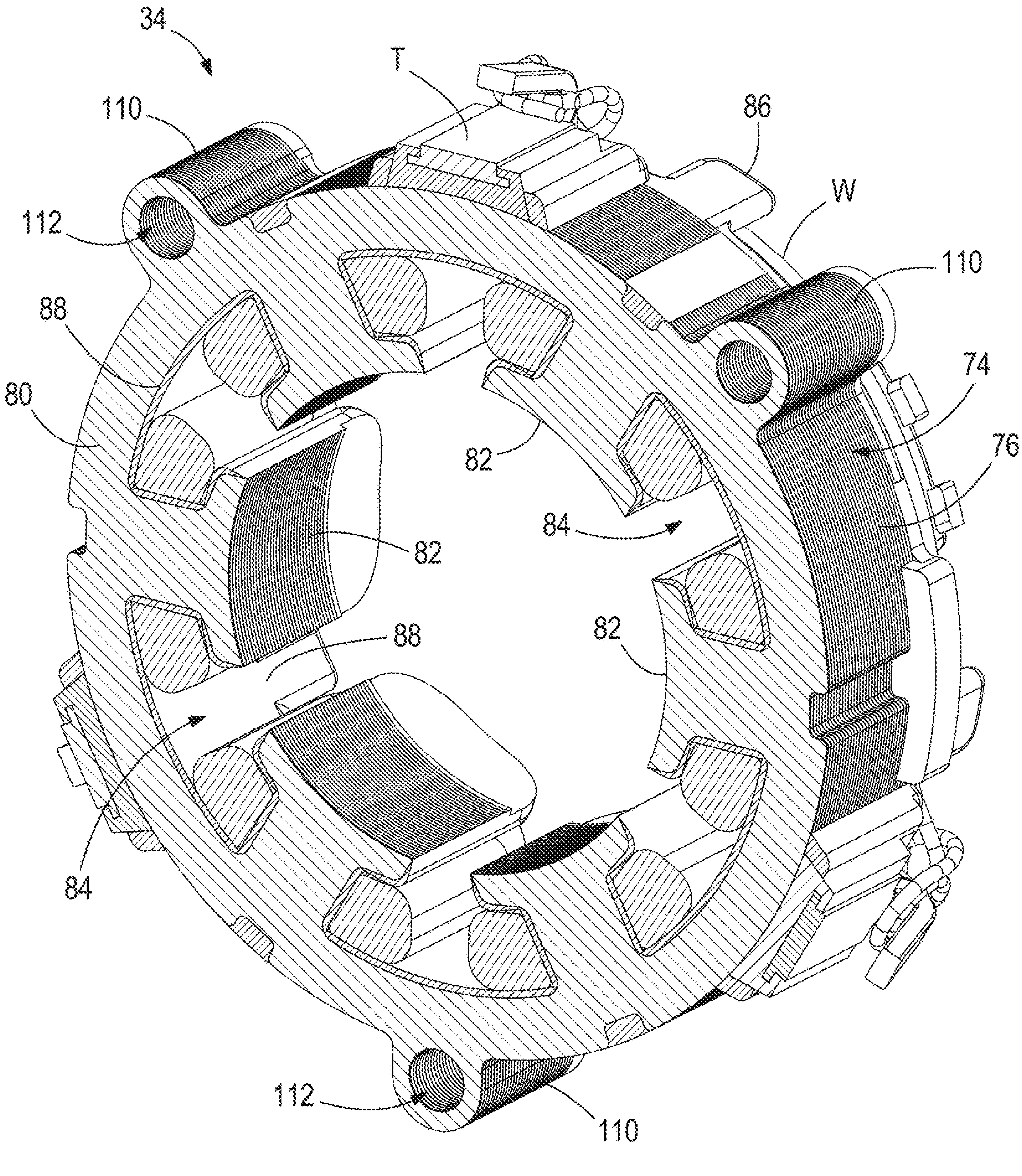

FIG. 13

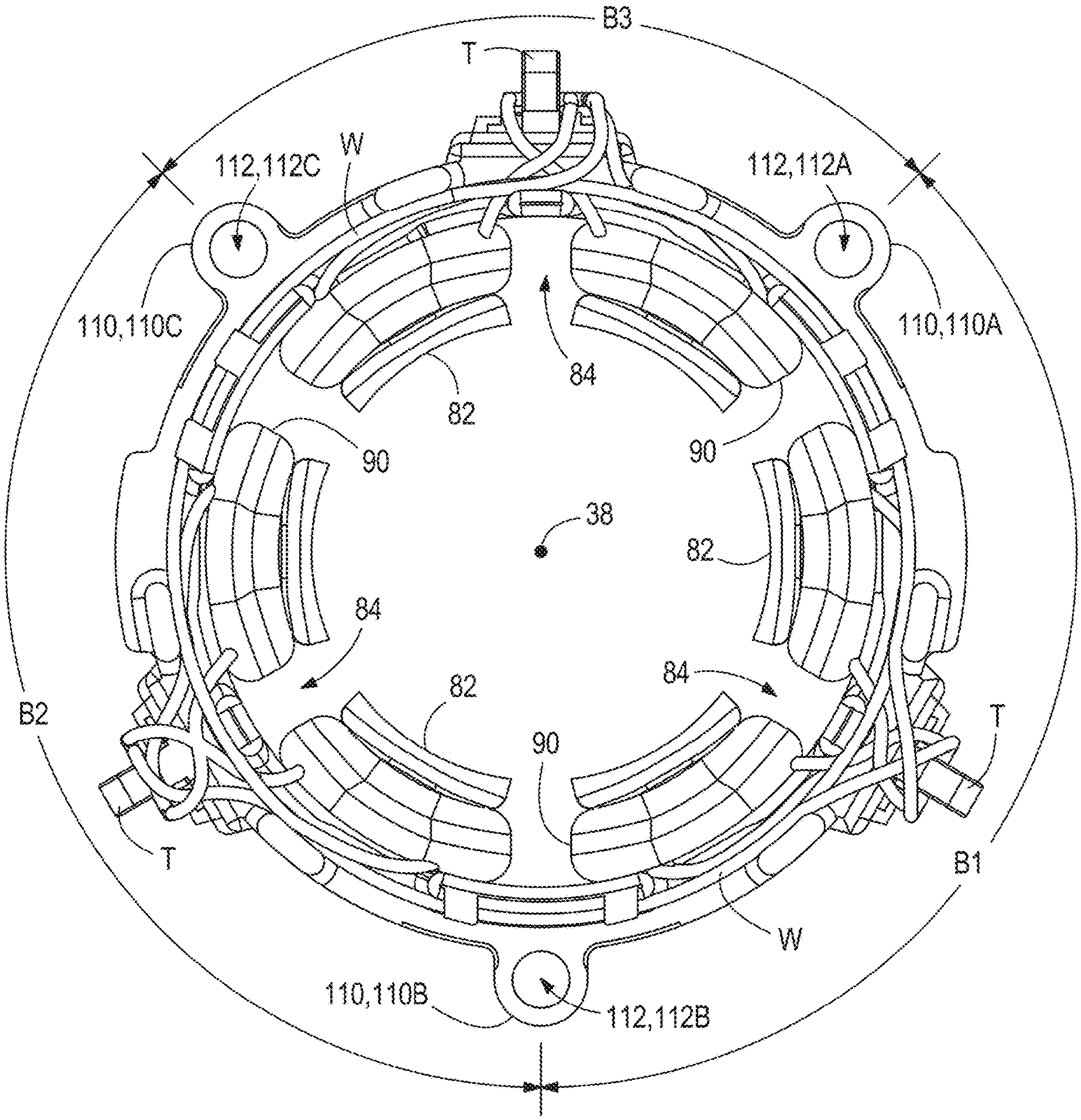
B3
T
W
112,112C
112,112A
110,110C
110,110A
84
82
90
90
38
82
84
84
82
90
B2
T
T
B1
W
110,110B
112,112B

FIG. 14

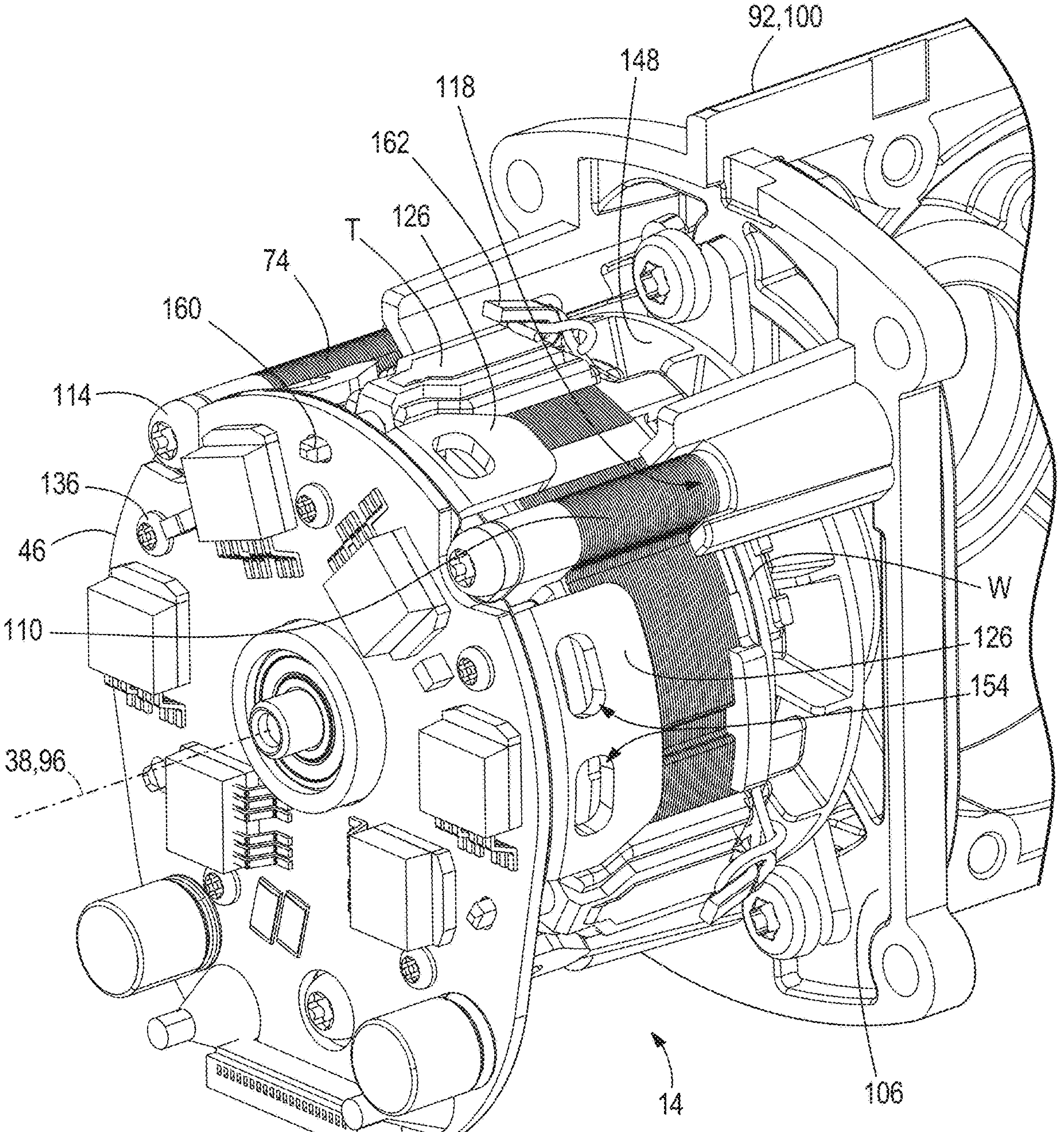
92,100
148
118
162
126
T
74
160
114
136
46
110
W
126
154
38,96
14
106

FIG. 15

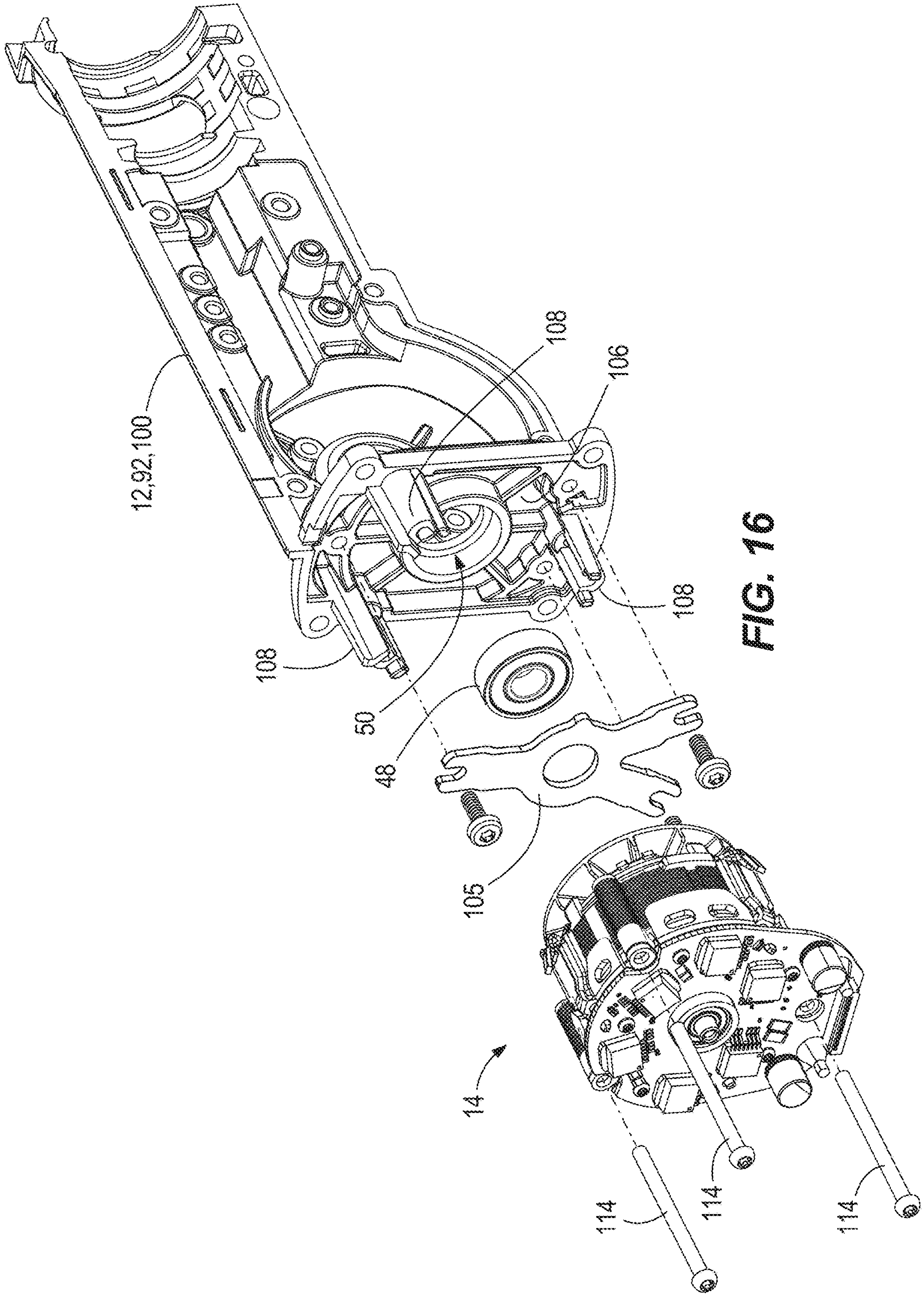

FIG. 16

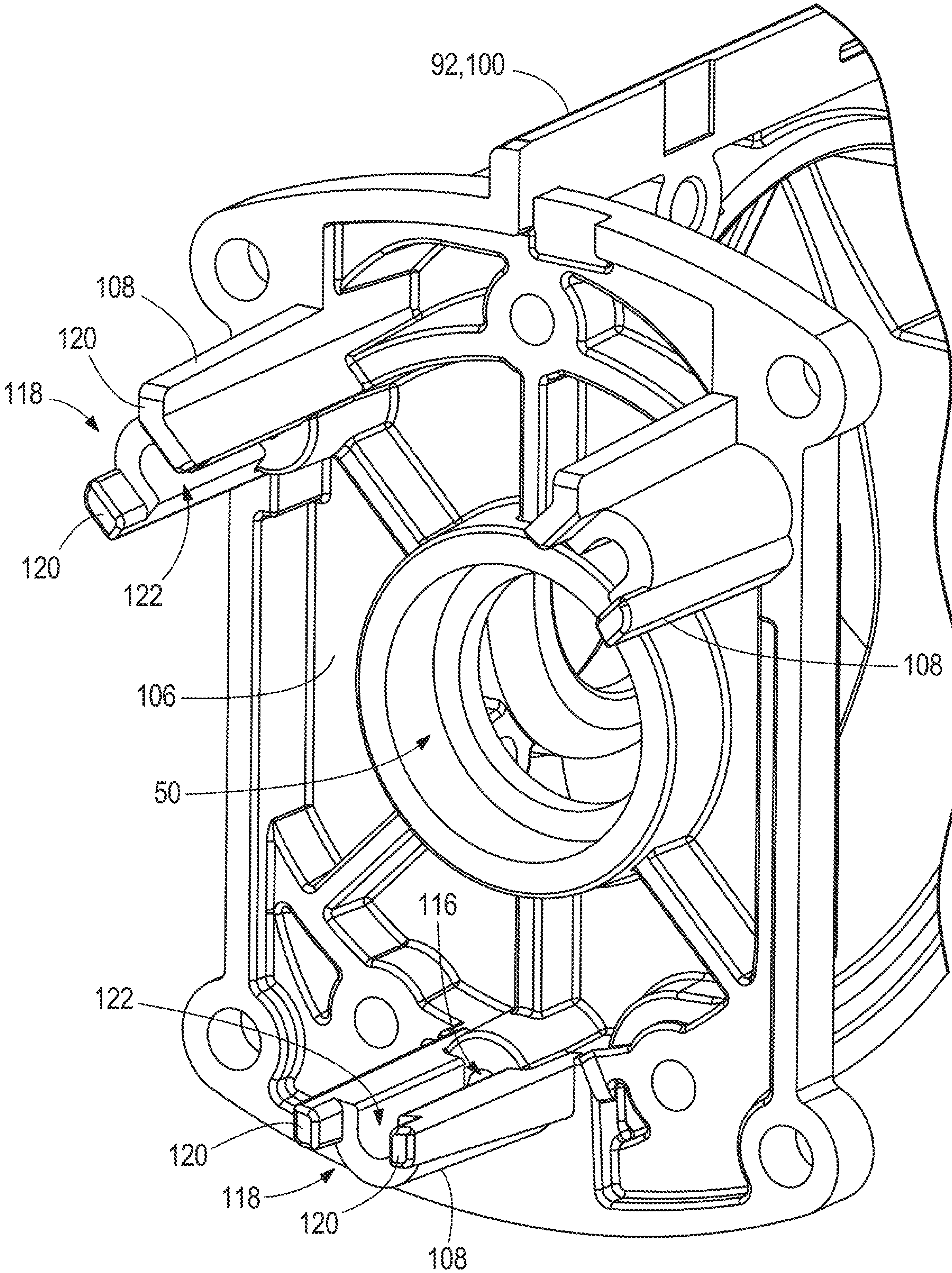

FIG. 17A

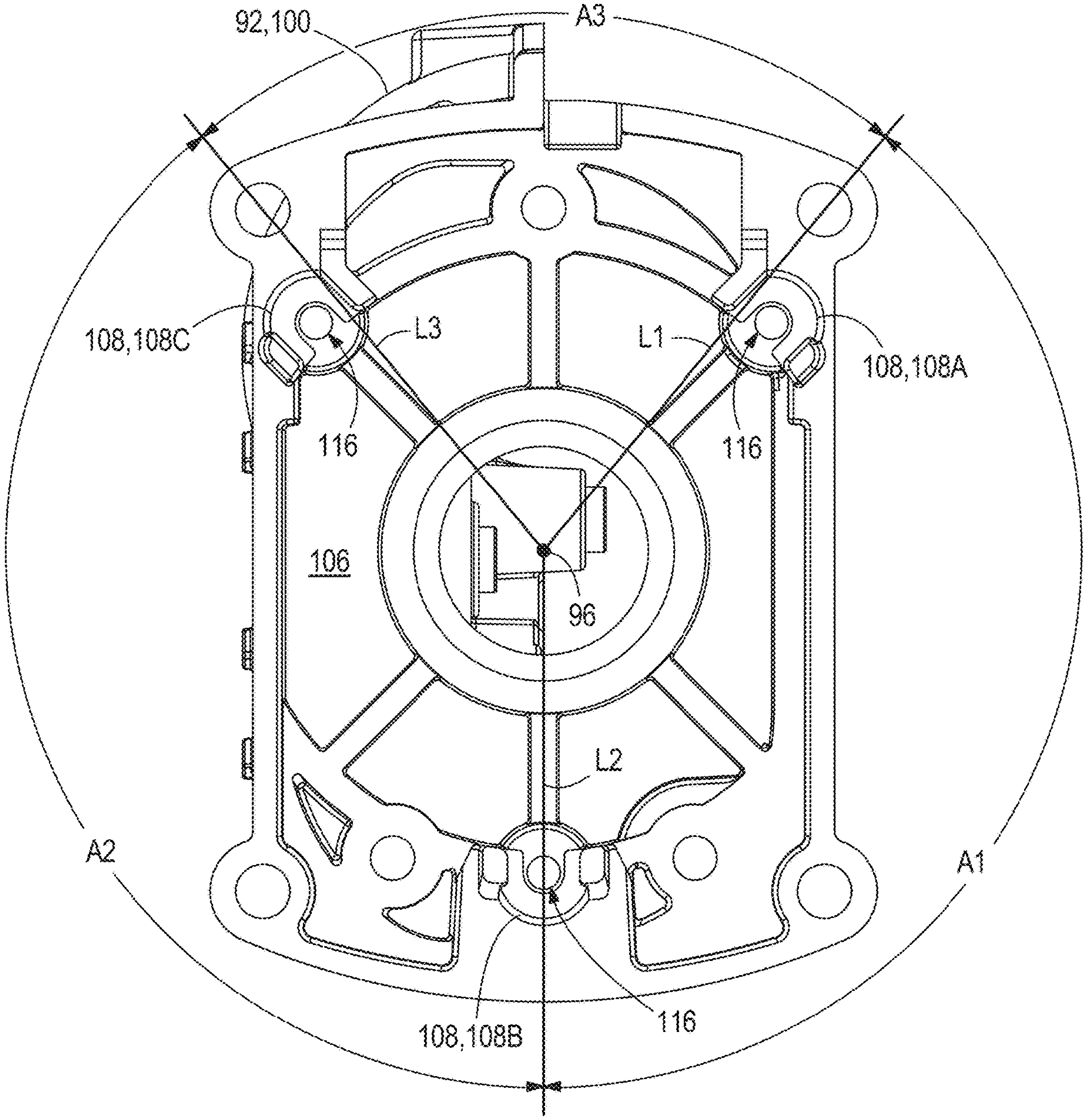
92,100
A3
108,108C
L3
L1
108,108A
116
116
106
96
L2
A2
A1
108,108B
116

FIG. 17B

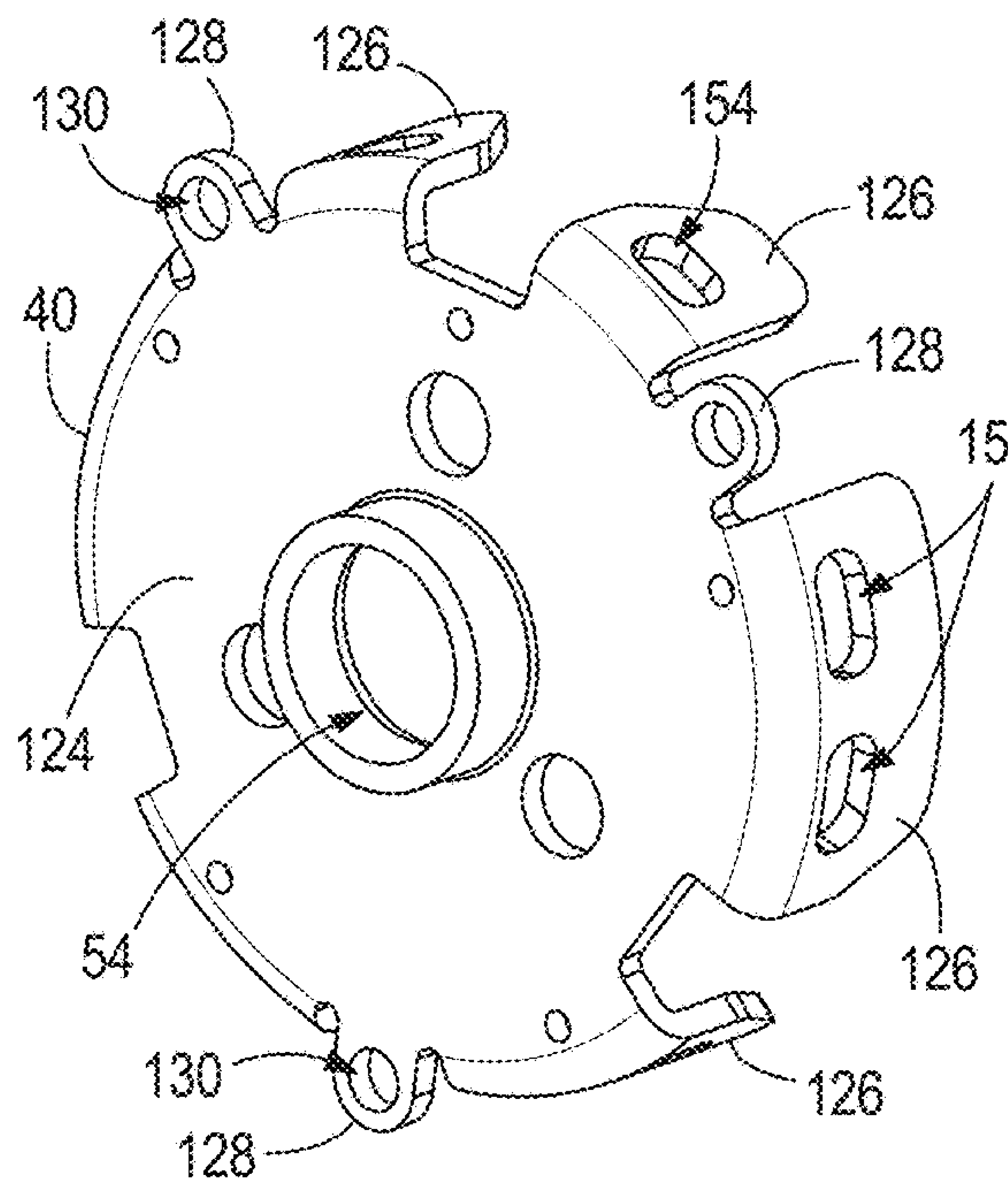

FIG. 18A

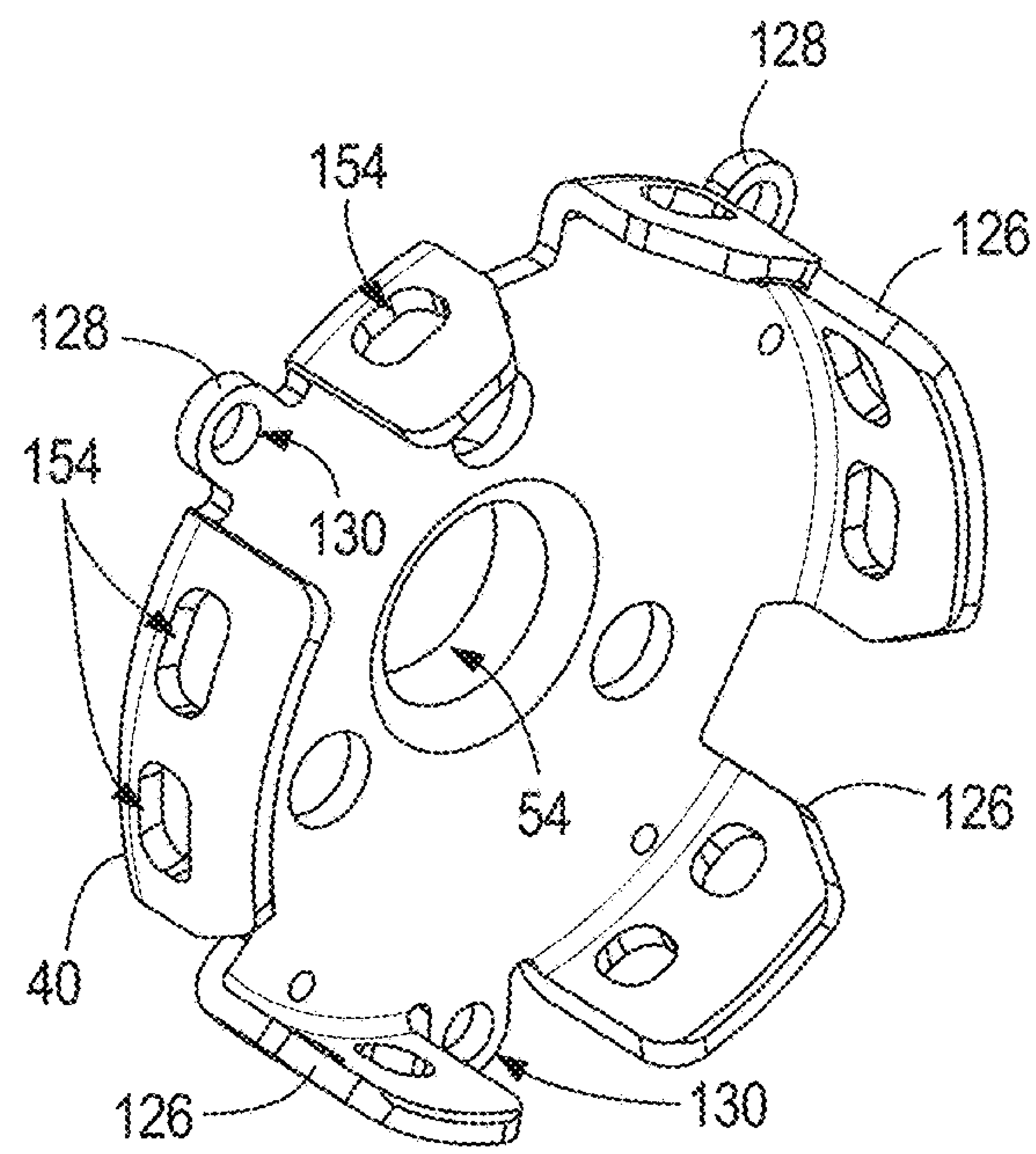

FIG. 18B

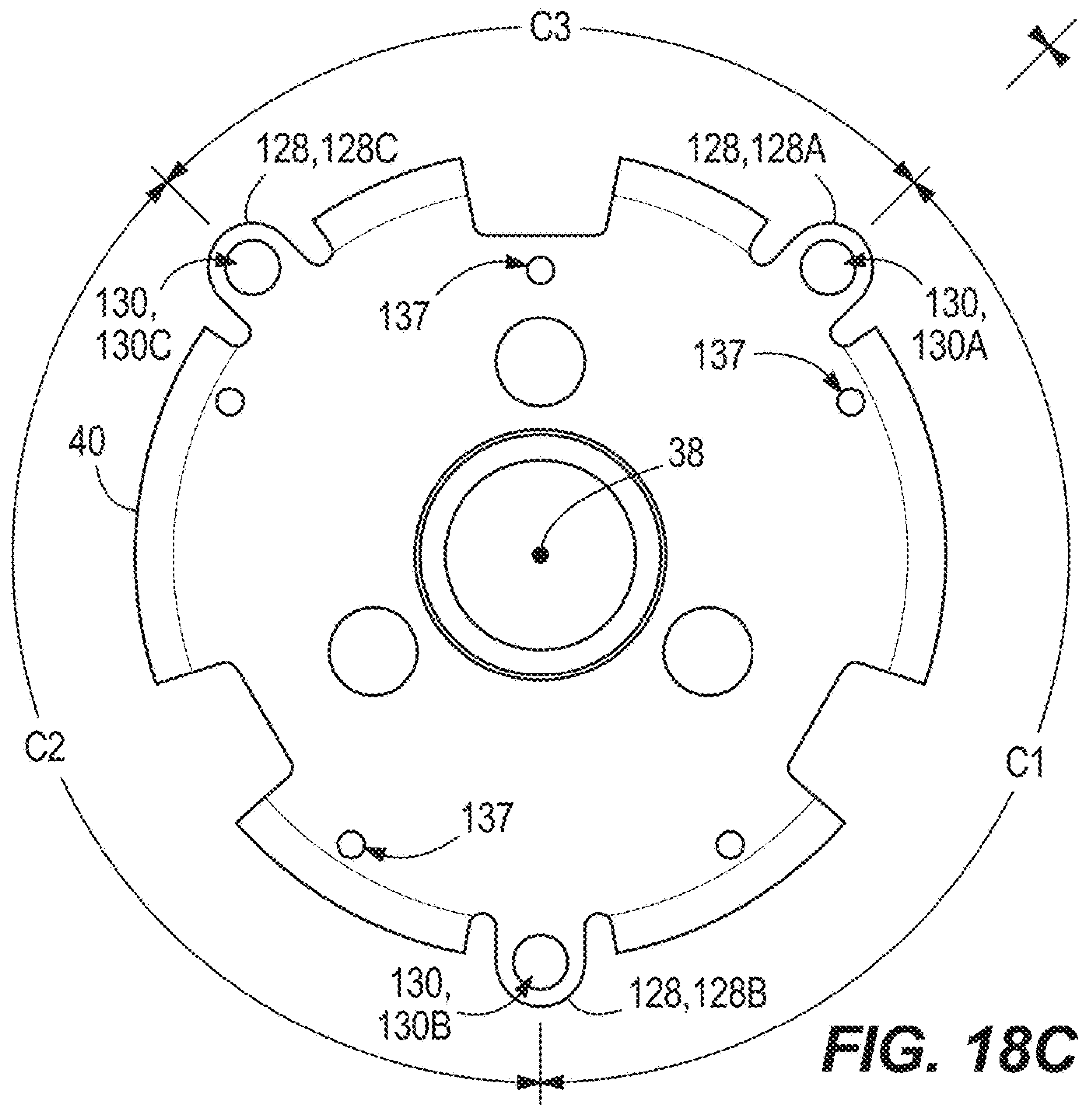

FIG. 18C

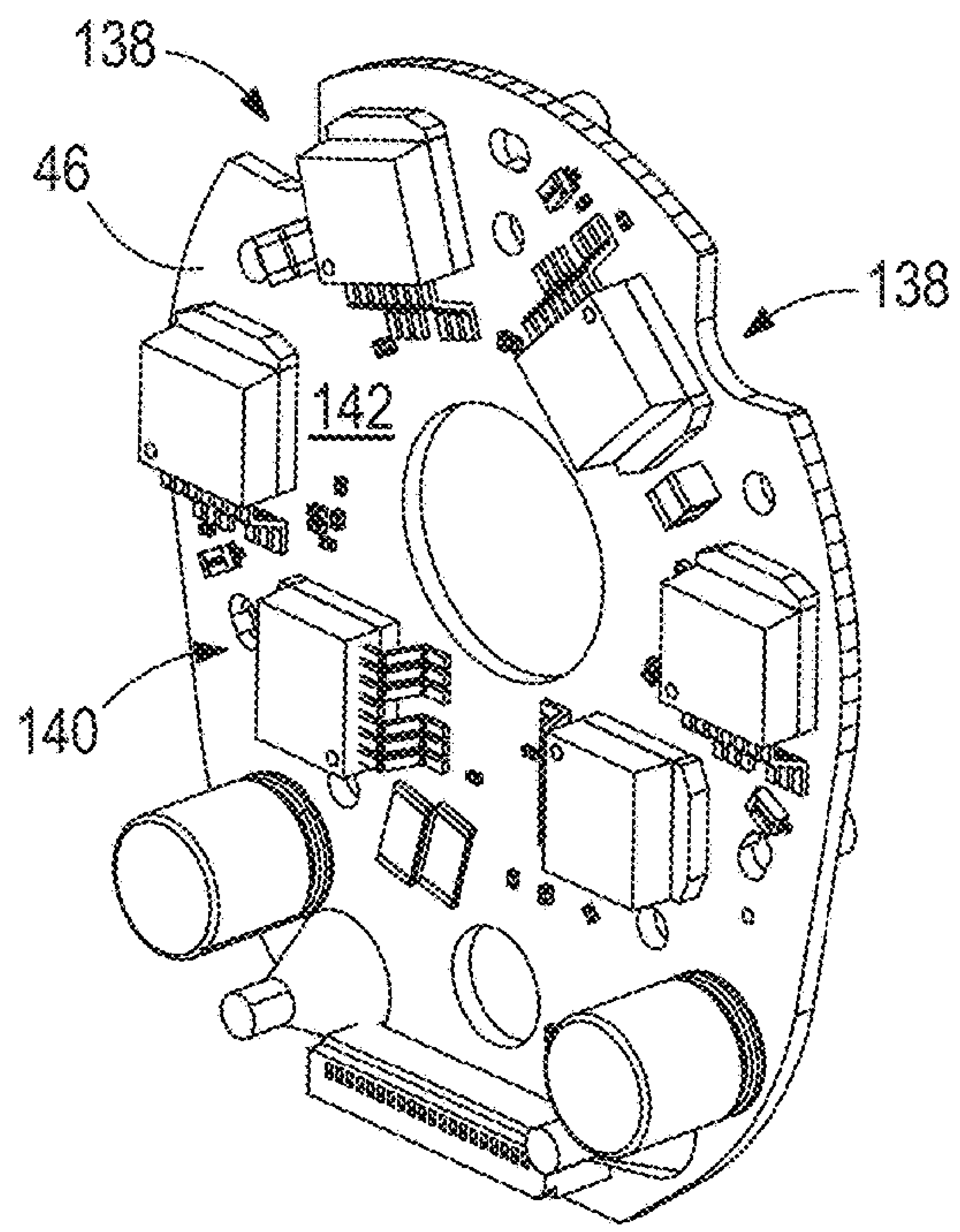

FIG. 19A

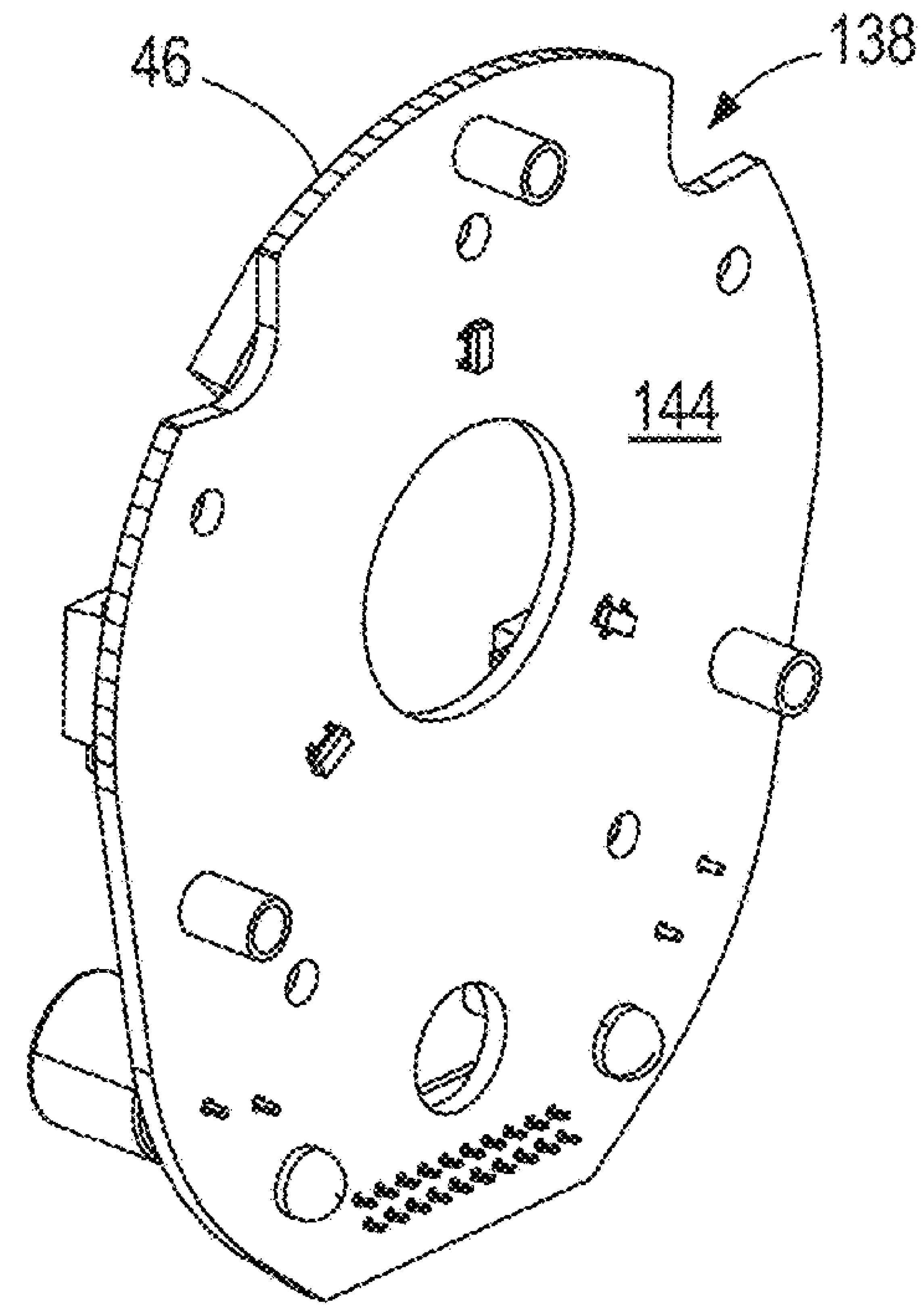

FIG. 19B

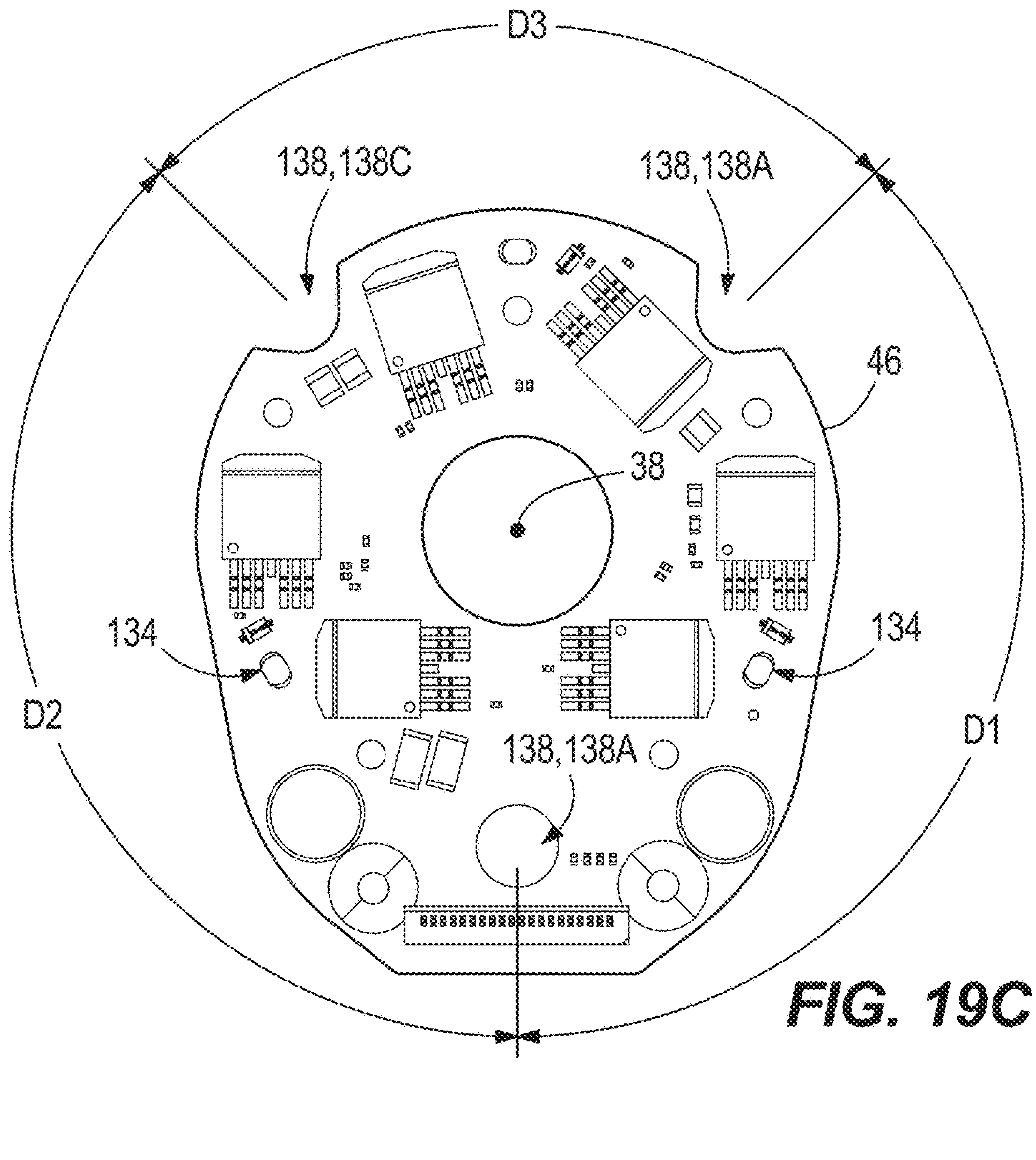

FIG. 19C

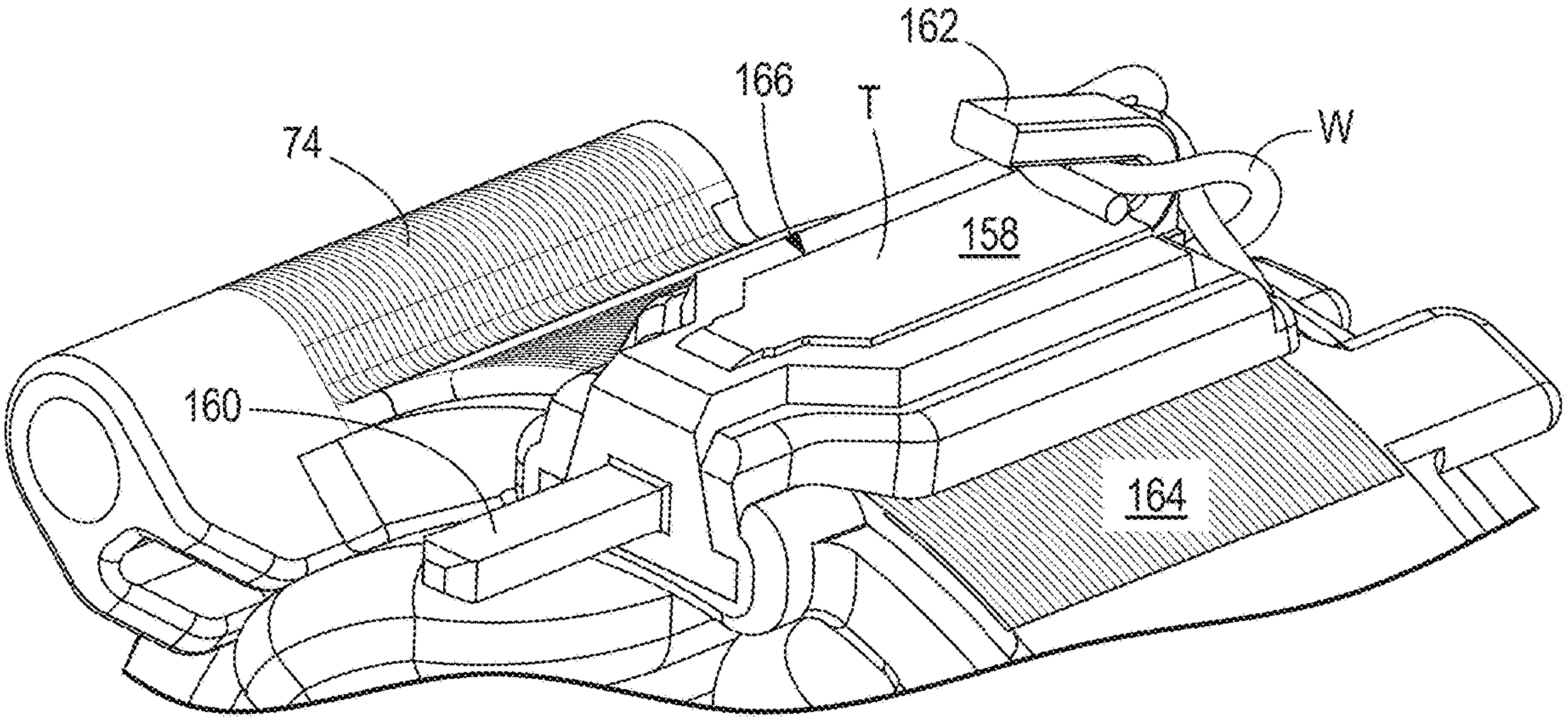
162
166
T
W
74
158
160
164

FIG. 20

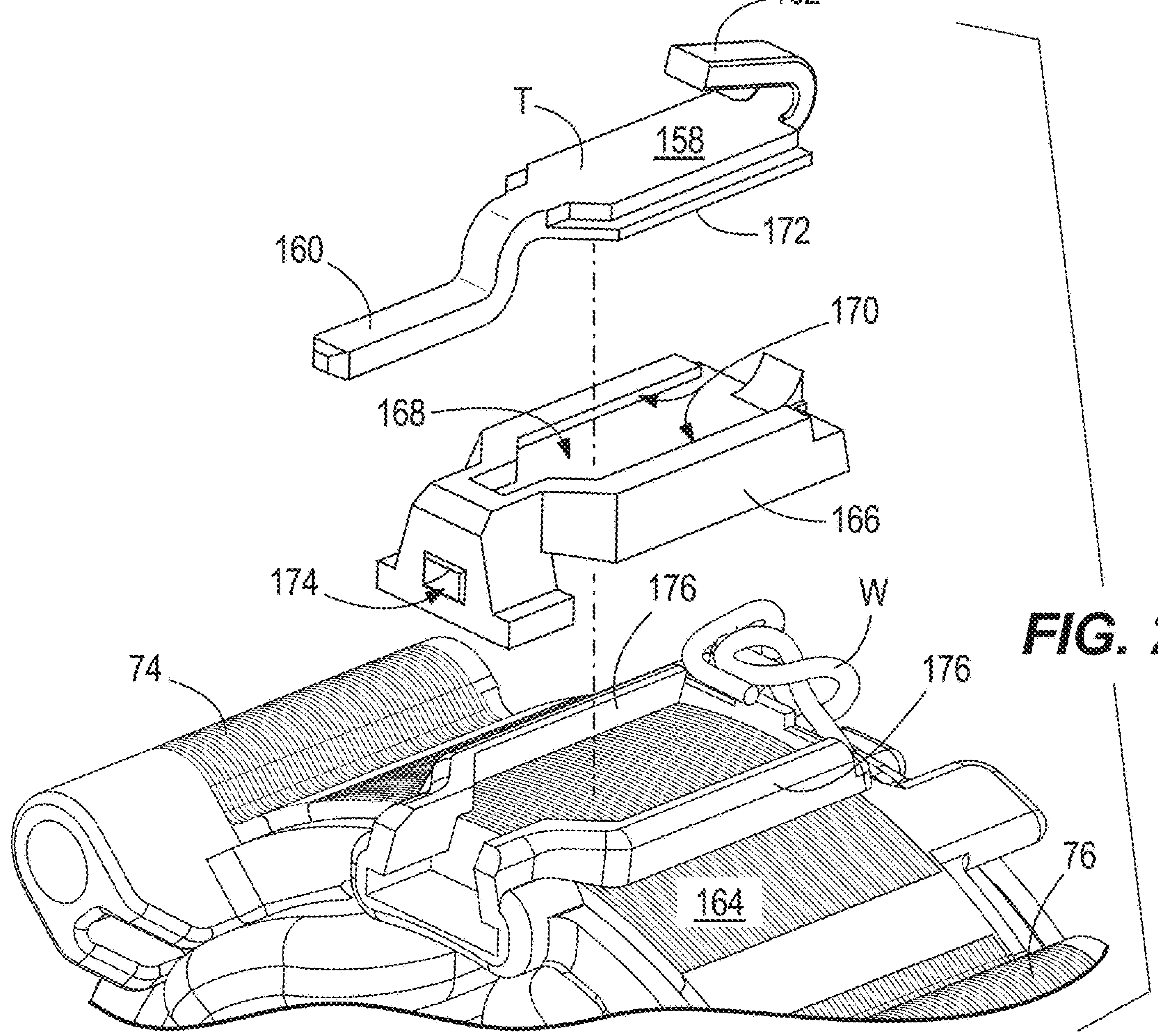
162
T
158
172
160
170
168
166
174
176
W
74
176
164
76

FIG. 21

ELECTRIC MOTOR FOR A POWER TOOL

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Patent Application No. 62/970,272, filed Feb. 5, 2020, the entire content of which is hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention relates to tools, such as power tools, and more particularly to power tools including an electric motor.

BACKGROUND OF THE INVENTION

Tools, such as power tools, can include an electric motor supported within a housing of the tool.

SUMMARY OF THE INVENTION

In one construction, a power tool includes a housing having a rear wall, a motor assembly coupled to the rear wall, and a plurality of mounting legs projecting from the rear wall toward the motor assembly. The motor assembly defines a motor axis, and includes a stator assembly defining a plurality of axially extending mounting apertures. Each mounting leg defines a threaded boss corresponding to a respective mounting aperture of the stator assembly, and each threaded boss is configured to receive a threaded fastener. The mounting legs are angularly spaced at unequal intervals about the motor axis.

In another construction, a power tool includes a housing and a motor assembly supported in the housing. The motor assembly includes a stator assembly, a circuit board proximate an end of the stator assembly, and a heat sink coupled to the stator assembly and in thermal contact with the circuit board. The circuit board including a heat-generating component. The heat sink includes an end wall defining a bearing pocket, and a plurality of axially extending cooling flanges extending from a periphery of the end wall.

In another construction, an electric motor assembly includes a circuit board and a stator assembly having a first end coupled to the circuit board and a second end opposite the first end. The stator assembly includes an annular stator body having a plurality of inwardly projecting teeth. The stator assembly also includes windings wrapped about the stator body to form a plurality of coils. The stator assembly further includes a terminal coupled to an outer periphery of the stator body and extending longitudinally between the first end and the second end. The terminal is coupled to the circuit board at the first end and is coupled to the windings at the second end to electrically connect the windings to the circuit board. The terminal is molded to an attachment member, and the attachment member is molded to the outer periphery of the stator body.

Other aspects of the application will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a power tool according to an embodiment of the invention.

FIG. **2** is another perspective view of the power tool of FIG. **1**.

FIG. **3** is a partially exploded perspective view of the power tool of FIG. **1** with portions removed.

FIG. **4** is a side view of the power tool of FIG. **1** with portions removed.

FIG. **5** is a side view of an electric motor of the power tool of FIG. **1**.

FIGS. **6** and **7** are partially exploded perspective views of the motor of FIG. **5**.

FIG. **8** is a perspective view of a rotor assembly of the motor of FIG. **5**.

FIG. **9** is another perspective view of the rotor assembly of FIG. **8** with portions removed.

FIG. **10** is an exploded perspective view of the rotor assembly of FIG. **8**.

FIG. **11** is a cross-sectional perspective view of the rotor assembly of FIG. **8** with portions removed, taken along line **11-11** of FIG. **9**.

FIG. **12** is a perspective view of a stator assembly of the motor of FIG. **5**.

FIG. **13** is a cross-sectional perspective view of the stator assembly of FIG. **12**, taken along lines **13-13** of FIG. **12**.

FIG. **14** is a front end view of the stator assembly of FIG. **12**.

FIG. **15** is a perspective view of the motor of FIG. **5** coupled to a portion of a gear case of the power tool of FIG. **1**.

FIG. **16** is a partially exploded perspective view of the motor of FIG. **5** and the gear case of FIG. **15**.

FIG. **17**A is a perspective view of a portion of the gear case of FIG. **15**.

FIG. **17**B is an end view of the gear case of FIG. **15**.

FIGS. **18**A and **18**B are perspective views of a heat sink of the motor of FIG. **5**.

FIG. **18**C is an end view of the heat sink of FIGS. **18**A and **18**B.

FIGS. **19**A and **19**B are perspective views of a printed circuit board (PCB) of the motor of FIG. **5**.

FIG. **19**C is an end view of the PCB of FIGS. **19**A and **19**B.

FIG. **20** is a partial perspective view of the stator assembly of FIG. **12**.

FIG. **21** is a partially exploded partial perspective view of the stator assembly of FIG. **12**.

Before any embodiments of the application are explained in detail, it is to be understood that the application is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The application is capable of other embodiments and of being practiced or of being carried out in various ways.

DETAILED DESCRIPTION

FIGS. **1** and **2** illustrate a power tool **10** (e.g., a saw operable to cut into a workpiece) that includes a housing **12** and a brushless direct current (DC) electric motor **14** (FIG. **3**) supported in the housing **12**. The motor **14** is electrically coupled to a rechargeable battery pack **16**, which is selectively coupled to the housing **12**. Using power from the battery pack **16**, a motor controller (e.g., one or more microprocessors connected to one or more printed circuit boards) operates the motor **14** to drive a drive mechanism **20** to reciprocate along a blade axis **22** in response to an actuator **24** (e.g., a trigger button) of the power tool **10** being depressed. The illustrated drive mechanism **20** includes a tool holder **26** that selectively couples a saw blade to the power tool **10** for the motor **14** to drive the saw blade to reciprocate along the blade axis **22**. In other embodiments, the electric motor **14** may be used in various different tools, such as other power tools (e.g., drills, rotary hammers, pipe threaders, cutting tools, etc.), outdoor tools (e.g., trimmers, pole saws, blowers, etc.), and other electrical devices (e.g., motorized devices, etc.), with the particular tool including an appropriate drive mechanism in order to carry out the specific function of the tool.

The battery pack **16** may include any of a number of different nominal voltages (e.g., 12V, 18V, etc.). The illustrated battery pack **16** is a lithium-ion battery pack, but in other embodiments, the battery pack **16** can be configured having any of a number of different chemistries (e.g., lead-acid, nickel-cadmium, nickel-metal hydride, etc.). Alternatively, the motor **14** may be powered by a remote power source (e.g., a household electrical outlet) through a power cord.

With reference to FIGS. **5-7**, the illustrated motor **14** includes a molded rotor assembly **28** having a rotor body **30** fixed to an output shaft **32** that is coupled to the drive mechanism **20**, a stator assembly **34** having a central cavity **36** that receives the rotor assembly **28** to rotate about a motor axis **38**, a heat sink **40** coupled to a rear end **42** of the stator assembly **34** opposite a front end **44**, and a printed circuit board (PCB) **46** coupled to the heat sink **40**. A front portion of the output shaft **32** is rotatably supported by a first bearing **48** (FIG. **16**) which, in the illustrated embodiment, is seated within a front bearing pocket **50** of the housing **12**. Likewise, a rear portion of the output shaft **32** is rotatably supported by a second bearing **52** (FIG. **6**), which is seated within a rear bearing pocket **54** defined by the heat sink **40**. In one embodiment, the second bearing **52** can be press fit into the rear bearing pocket **54** of the heat sink **40**.

With reference to FIGS. **8-11**, the rotor body **30** includes an integral fan and magnet retention **56** (FIG. **10**) formed of an insulative material (e.g., plastic) that is molded to a rotor lamination stack **58**. The integral fan and magnet retention **56** includes a fan portion **60** and a magnet retention portion **62** formed opposite the fan portion **60**. The fan portion **60** and the magnet retention portion **62** abut opposite ends of the lamination stack **58** to retain permanent magnets **64** (FIG. **10**) located within the lamination stack **58**.

The lamination stack **58** defines a longitudinally extending central aperture **66** that receives the output shaft **32** (e.g., by interference fit). Magnet slots **68** (FIG. **10**) are formed in the lamination stack **58** and receive the permanent magnets **64**. The lamination stack **58** also includes injection channels **70** formed about the central aperture **66** and extending longitudinally between the fan portion **60** and magnet retention portion **62**. When the integral fan and magnet retention **56** is molded to the lamination stack **58**, the insulative material of the integral fan and magnet retention **56** flows through the channels **70** and joins the fan portion **60** to the magnet retention portion **62**. The insulative material also extends around the magnets **64** within the magnet slots **68** to form magnet holding portions **72** (FIG. **10**). The magnet holding portions **72** extend through the magnet slots **68** between the fan portion **60** and the magnet retention portion **62**, and surround the permanent magnets **64** to retain the magnets **64** within the slots **68**.

With reference to FIGS. **12-14**, the stator assembly **34** includes a stator body **74** having a lamination stack **76** and a molded insulator member **78** formed of an insulative material (e.g., plastic) that is molded to the lamination stack **76**. In the illustrated embodiment, the lamination stack **76** includes an annular yoke **80** and six stator teeth **82** (FIG. **13**) extending inwardly in a generally radial direction from the yoke **80**. Stator slots **84** are defined between adjacent pairs of the teeth **82**. The insulator member **78** includes a pair of end insulators or bobbins **86** disposed at each axial end face of the lamination stack **76**, and slot insulators **88** (FIG. **13**) extending through the slots **84** to cover the inner surfaces of the slots **84** and connect the pair of bobbins **86**.

Windings W (FIG. **14**) are routed through the slots **84** and wound about the respective teeth **82** to form coils **90**. The windings W are electrically connected to terminals T (FIG. **5**), which in turn are electrically connected to the PCB **46** that selectively applies power to the windings W to cause the output shaft **32** to rotate about the motor axis **38** to operate the drive mechanism **20**.

With reference to FIGS. **1-4**, the housing **12** includes a gear case **92** and a rear housing portion **94** coupled to the gear case **92**. The housing **12** also defines a longitudinal axis **96** (FIG. **4**) that extends through the gear case **92** and the rear housing portion **94**. The rear housing portion **94** includes a D-shaped handle **98** that supports the actuator **24**. The gear case **92** is comprised of first and second clamshell halves **100**, **102** that are connected together along a mating plane **104** (FIG. **3**). In the illustrated embodiment, the clamshell halves **100**, **102** are secured together with threaded fasteners (e.g., screws).

As shown in FIGS. **4** and **15**, the motor **14** is positioned within the rear housing portion **94** and affixed to the gear case **92**. In the illustrated embodiment, the motor axis **38** of the motor **14** is generally aligned or coaxial with the longitudinal axis **96** of the housing **12**. The first clamshell half **100** includes a rear wall **106** that extends generally orthogonal to the longitudinal axis **96**. The front bearing pocket **50** (FIG. **16**) is formed in the rear wall **106**. The first bearing **48** is received into the front bearing pocket **50**, and a bearing retainer **105** (FIG. **16**) is coupled to the rear wall **106** to retain the first bearing **48** within the front bearing pocket **50**.

As shown in FIGS. **4**, **17**A, and **17**B, the motor **14** is supported by motor mounting legs **108** extending from the rear wall **106** toward the rear housing portion **94** along an axial direction generally parallel to the longitudinal axis **96**. The mounting legs **108** correspond to axially extending mounting ribs **110** (FIG. **12**) projecting radially outward from the stator body **74** and spaced about a circumference thereof. Axially-extending mounting apertures **112** are formed within the mounting ribs **110** and configured to receive fasteners **114** (FIG. **16**) for securing the motor **14** to the gear case **92**. In the illustrated embodiment, there are three mounting legs **108** projecting from the gear case **92** and corresponding to three mounting ribs **110**. In other embodiments, there may be fewer (e.g., two) or more (e.g., four, five, etc.) mounting legs **108** and corresponding mounting ribs **110**.

Each mounting leg **108** defines a threaded aperture **116** proximate the rear wall **106**, an alignment groove **118** located between two projections or prongs **120** projecting from a distal end, and a channel **122** extending longitudinally between the threaded aperture **116** and the alignment groove **118**. The alignment groove **118** receives a portion of the corresponding mounting rib **110** of the stator body **74** (as shown in FIG. **15**) to align the motor **14** with respect to the gear case **92** during assembly. The fasteners **114** extend through the mounting apertures **112** of the stator body **74** and within the channels **122** of the mounting legs **108**, and thread into the threaded apertures **116** to secure the motor **14** to the gear case **92**.

With reference to FIG. **17**B, the mounting legs **108** are angularly spaced asymmetrically or at unequal intervals about the longitudinal axis **96**. In the illustrated embodiment, the mounting legs **108** include a first mounting leg **108**A, a second mounting leg **108**B, and a third mounting leg **108**C. First, second, and third reference lines L**1**, L**2**, and L**3** originate at the longitudinal axis **96** and extend to intersect the first, second, and third mounting legs **108**A, **108**C, and **108**C, respectively. The first and second reference lines L**1**, L**2** define a first mounting leg angle A**1** therebetween. Similarly, the second and third reference lines L**2**, L**3** define a second mounting leg angle A**2**, and the first and third reference lines L**1**, L**3** define a third mounting leg angle A**3**. In other words, the first and second mounting legs **108**A, **108**B are angularly spaced about the longitudinal axis **96** by the first mounting leg angle A**1**, the second and third mounting legs **108**B, **108**C are spaced about the longitudinal axis **96** by the second mounting leg angle A**2**, and the first and third mounting legs **108**A, **108**C are spaced about the longitudinal axis **96** by the third mounting leg angle A**3**. In the illustrated embodiment, the first and second mounting leg angles A**1** and A**2** are equal to one another, and both differ from the third mounting leg angle A**3**, i.e., A**1**=A**2**≠A**3**.

With reference to FIG. **14**, mounting ribs **110** and corresponding mounting apertures **112** of the stator body **74** are likewise spaced at unequal intervals about the motor axis **38**. As shown in FIG. **14**, the mounting ribs **110** include first, second, and third mounting ribs **110**A, **110**B, and **110**C defining associated first, second, and third mounting apertures **112**A, **112**B, and **112**C. In a manner similar to that described above, the first and second mounting ribs **110**A, **110**B are angularly spaced about the motor axis **38** by a first mounting rib angle B**1**, the second and third mounting ribs **110**B, **110**C are spaced about the motor axis **38** by a second mounting rib angle B**2**, and the first and third mounting ribs **110**A, **110**C are spaced about the motor axis **38** by a third mounting rib angle B**3**. In the illustrated embodiment, the first and second mounting rib angles B**1** and B**2** are equal to one another, and both differ from the third mounting rib angle B**3**, i.e., B**1**=B**2**≠B**3**.

Due to the unequal angular spacing of the mounting legs **108** of the gear case **92** and the corresponding mounting ribs **110** and associated mounting apertures **112** of the stator body **74**, as described above, the motor **14** and the gear case **92** only couple together in a single orientation at which the mounting ribs **110** may be partially received into the corresponding alignment grooves **118** as shown in FIG. **15**. This ensures that the motor **14** is properly aligned to the gear case **92** during assembly of the power tool **10** and eliminates any risk for misalignment, thus improving the manufacturability of the power tool **10**.

With reference to FIGS. **18**A-**18**C, the heat sink **40** is generally cup-shaped and includes an end wall **124** that mates with the PCB **46** (FIG. **6**) and includes the rear bearing pocket **54**, and axially-extending cooling flanges **126** spaced about a periphery of the end wall **124** and extending toward the stator body **74**. Mounting tabs **128** extend radially outward from the perimeter of the end wall **124** and define fastener apertures **130** corresponding to the mounting ribs **110** and associated mounting apertures **112** of the stator body **74**. The mounting tabs **128** include first, second, and third mounting tabs **128**A, **128**B, and **128**C defining associated first, second, and third fastener apertures **130**A, **130**B, and **130**C. In a manner similar to that described above, the first and second mounting tabs **128**A, **128**B are angularly spaced about the motor axis **38** by a first mounting tab angle C**1**, the second and third mounting tabs **128**B, **128**C are spaced about the motor axis **38** by a second mounting tab angle C**2**, and the first and third mounting tabs **128**A, **128**C are spaced about the motor axis **38** by a third mounting tab angle C**3**. In the illustrated embodiment, the first and second mounting tab angles C**1** and C**2** are equal to one another, and both differ from the third mounting tab angle C**3**, i.e., C**1**=C**2**≠C**3**.

Due to the unequal angular spacing of the mounting tabs **128** and associated fastener apertures **130** of the heat sink **40**, and of the corresponding mounting ribs **110** and associated mounting apertures **112** of the stator body **74**, as described above, the heat sink **40** can only be coupled to the stator body **74** in a single orientation at which the fastener apertures **130** align with the mounting apertures **112**. This ensures that the heat sink **40** and the stator body **74** only couple together in a single orientation at which the cutouts **138** align with the corresponding mounting ribs **110** and associated mounting apertures **112** (FIG. **14**). This ensures that the heat sink **40** is properly aligned to the stator body **74** during assembly of the motor **14** and eliminates any risk for misalignment, thus improving the manufacturability of the motor **14** and the power tool **10**.

When the gear case **92** is assembled with the motor **14**, the fasteners **114** extend through the fastener apertures **130** and the mounting apertures **112**, and thread into the threaded apertures **116** of the gear case **92**. By tightening the fasteners **114**, the heat sink **40** and the mounting legs **108** apply a clamping force to the stator body **74**, thereby fixing the stator body **74** to the heat sink **40** and to the mounting legs **108**.

With reference to FIGS. **15** and **19**A-**19**C, the PCB **46** is coupled to the heat sink **40** via PCB fasteners **136**. Specifically, the PCB **46** includes mounting apertures **134**, and the heat sink **40** includes corresponding threaded apertures **137** (FIG. **18**C) so that when the PCB **46** is placed against the heat sink **40**, the mounting apertures **134** and the threaded apertures **137** align and receive the PCB fasteners **136** to secure the PCB **46** to the heat sink **40**.

With continued reference to FIGS. **15** and **19**A-**19**C, the PCB **46** also includes fastener cutouts **138** corresponding to the fasteners **114** securing the motor **14** to the gear case **92**. The fastener cutouts **138** permit the fasteners **114** to pass through without engaging the PCB **46**, thus reducing strain on the PCB **46** that would otherwise result from any forces exerted on the PCB **46** by the fasteners **114**.

Moreover, the cutouts **138** are angularly spaced about the motor axis **38** asymmetrically or at unequal intervals, in a manner similar to that described above with respect to the mounting legs **108**, the mounting ribs **110** and associated mounting apertures **112**, and the mounting tabs **128** and associated fastener apertures **130**. As shown in FIG. **19**C, the cutouts **138** include first, second, and third cutouts **138**A, **138**B, and **138**C. In a manner similar to that described above, the first and second cutouts **138**A, **138**B are angularly spaced about the motor axis **38** by a first cutout angle D**1**, the second and third cutouts **138**B, **138**C are spaced about the motor axis **38** by a second cutout angle D**2**, and the first and third cutouts **138**A, **138**C are spaced about the motor axis **38** by a third cutout angle D**3**. In the illustrated embodiment, the first and second cutout angles D**1** and D**2** are equal to one another, and both differ from the third cutout angle D**3**, i.e., D**1**=D**2**≠D**3**. This ensures that the PCB **46** and the heat sink **40** only couple together in a single orientation at which the cutouts **138** align with the corresponding mounting ribs **110** and associated mounting apertures **112** (FIG. **14**) of the stator body **74**, and eliminates any risk for misalignment, thus improving the manufacturability of the motor **14** and the power tool **10**.

The PCB **46** includes heat-generating components **140** (e.g., semiconductor FETs, current sense resistors, thermistors, capacitors, diodes, voltage sensors, etc.) supported on a first side **142** of the PCB **46**. As such, the heat-generating components **140** face away from the stator body **74**. A second side **144** of the PCB **46** faces toward the heat sink **40** and is in direct contact with one side of a thermal pad **146** (FIG. **6**) (e.g., a highly thermal conductive member such as copper, aluminum, etc.) and another side of the thermal pad **146** is in direct contact with the end wall **124** of the heat sink **40**. In other embodiments, the thermal pad **146** can be omitted such that the PCB **46** directly contacts the heat sink **40**.

With reference to FIGS. **8** and **15**, the fan portion **60** of the rotor body **30** includes an impeller **148**. When the power tool **10** is assembled with the motor **14**, the impeller **148** is positioned between the stator body **74** and the rear wall **106** of the gear case **92**. The illustrated impeller **148** includes cooling blades **150** extending toward the stator body **74** and radially aligned with an exhaust aperture **152** (FIG. **2**) formed through the rear housing portion **94**. In turn, the cooling flanges **126** of the heat sink **40** include airflow apertures **154** (FIGS. **18**A and **18**B) formed therein and located proximate inlet apertures **156** (FIG. **2**) formed through the rear housing portion **94**. The cooling flanges **126** of the heat sink **40** increase the thermal surface area and mass of the heat sink **40**, which improves heat dissipation and removal from the PCB **46**. Moreover, the airflow apertures **154** within the cooling flanges **126** allow for a cooling airflow generated by the impeller **148** to pass through and over the heat sink **40** to improve thermal energy removal and reduce the amount of recirculated air.

In operation, the battery pack **16** provides DC power to the heat-generating components **140** of the PCB **46**. As the electrical current travels through the PCB **46**, the electrical current provides operating power to the heat-generating components **140** so that power from the battery pack **16** is selectively applied to the stator assembly **34** to cause rotation of the output shaft **32** about the motor axis **38** to operate the drive mechanism **20**. As the electrical current passes through the heat-generating components **140**, the components **140** generate heat (i.e., thermal energy), which if not dissipated, could otherwise impair the performance of the motor **14**. The heat sink **40** removes thermal energy from the PCB **46**, and directs the thermal energy away from the stator body **74** and the rotor assembly **28**. In particular, the thermal energy generated by the heat-generating components **140** dissipates through the thermal pad **146** and into the end wall **124**, a portion of which is ultimately dissipated by convection (at least partially) occurring at the cooling flanges **126**.

Moreover, when the motor **14** is actively operating, the impeller **148** of the fan portion **60** rotates about the motor axis **38** to induce an airflow through the motor **14**. In particular, as the output shaft **32** rotates, the airflow enters the rear housing portion **94** via the inlet apertures **156** and flows into the motor **14** through the airflow apertures **154** formed in the cooling flanges **126**. The airflow draws heat away from the heat sink **40**, continues to travel forwardly through the central cavity **36** between the stator body **74** and the rotor body **30**, exits the motor **14** adjacent the impeller **148**, and exhausts out of the rear housing portion **94** through the exhaust aperture **152**.

As shown in FIG. **12**, in the illustrated embodiment, the motor **14** includes three terminals T that are longitudinally arranged along an outer periphery of the stator body **74** and spaced apart from one another in the circumferential direction at generally equal intervals. With reference to FIGS. **20** and **21**, each terminal T comprises an elongated conductive member formed from, e.g., copper, brass, etc. As mentioned above, the terminals T are electrically connected to the windings W at the fan end or front end **44** of the stator assembly **34**, and are electrically connected to the PCB **46** at the board end or rear end **42** of the stator assembly **34** to conduct DC current between the PCB **46** and the windings W.

In the illustrated embodiment, each terminal T includes a central plate **158**, a connecting portion **160** extending from the central plate **158** and electrically coupled to the PCB **46** at the rear end **42**, and a hook portion or tang **162** extending from the central plate **158** opposite the connecting portion **160** and configured to engage the windings W at the front end **44**. Each tang **162** extends away from the central plate **158**, and then bends backward toward the central plate **158** to form a hook shape. The windings W wrap around the tang **162** to electrically connect to the terminals T at the front end **44** of the stator assembly **34**.

With continued reference to FIGS. **20** and **21**, each terminal T is attached to a circumferential outer surface **164** of the stator body **74** via a thermal set or attachment member **166**. The attachment member **166** includes a receiving portion **168** having grooves **170** that receive rails **172** formed on the central plate **158**, and a channel **174** that receives a portion of the connecting portion **160** to secure the terminal T to the attachment member **166**. The molded insulator member **78** of the stator body **74** includes retaining walls **176** extending longitudinally along the circumferential outer surface **164** of the lamination stack **76**. The retaining walls **176** engage the attachment member **166** to secure the attachment member to the stator body **74**.

To secure each terminal T to the stator body **74**, first the terminal T is insert molded to the attachment member **166**. Then, the combined terminal T and attachment member **166** is subsequently insert molded onto the stator body **74** (i.e., during molding process by which the insulator member **78** is molded to the lamination stack **76**).

Various features of the disclosure are set forth in the following claims.

What is claimed is:

1. A power tool comprising:

a housing defining a longitudinal axis and including a rear wall;

a motor assembly coupled to the rear wall, the motor assembly including a stator assembly defining a plurality of axially extending mounting apertures;

a plurality of mounting legs projecting from the rear wall toward the motor assembly, each mounting leg defining a threaded boss corresponding to a respective mounting aperture of the stator assembly, each threaded boss configured to receive a threaded fastener;

wherein the mounting legs are angularly spaced at unequal intervals about the longitudinal axis.

2. The power tool of claim **1**, wherein the rear wall extends perpendicular to the longitudinal axis.

3. The power tool of claim **2**, wherein the mounting legs include a first mounting leg, a second mounting leg, and a third mounting leg.

4. The power tool of claim **3**, wherein a first mounting leg angle **A1** is defined between the first mounting leg and the second mounting leg about the longitudinal axis, a second mounting leg angle **A2** is defined between the second mounting leg and the third mounting leg about the longitudinal axis, and a third mounting leg angle **A3** is defined between the third mounting leg and the first mounting leg about the longitudinal axis, and wherein $A1=A2\neq A3$.

5. The power tool of claim 1, wherein the stator assembly includes a stator body having a plurality of axially extending mounting ribs projecting radially outward from the stator body, and wherein the mounting apertures are defined in the mounting ribs.

6. The power tool of claim 5, wherein each mounting aperture aligns with a corresponding mounting leg.

7. The power tool of claim 5, wherein each mounting leg includes a pair of projections and an alignment groove defined between the projections, and wherein a portion of each mounting rib is received into a corresponding alignment groove.

8. The power tool of claim 5, further comprising:

a circuit board proximate an end of the stator assembly, the circuit board including a heat-generating component; and

a heat sink coupled to the stator assembly and in thermal contact with the circuit board, the heat sink including a plurality of mounting tabs extending outward from a periphery of the heat sink and defining fastener apertures;

wherein each fastener aperture aligns with a corresponding mounting aperture.

9. A power tool comprising:

a housing;

a motor assembly supported in the housing, the motor assembly including a stator assembly,

a circuit board proximate an end of the stator assembly, the circuit board including a heat-generating component, and

a heat sink coupled to the stator assembly and in thermal contact with the circuit board, the heat sink having an end wall defining a bearing pocket, and a plurality of axially extending cooling flanges extending from a periphery of the end wall.

10. The power tool of claim 9, wherein each cooling flange defines an airflow aperture.

11. The power tool of claim 9, wherein the circuit board is fastened to the heat sink via first fasteners.

12. The power tool of claim 9, wherein the stator assembly defines a plurality of axially extending mounting apertures, and wherein the housing defines a rear wall and a plurality of mounting legs projecting from the rear wall toward the motor assembly, each mounting leg defining a threaded boss corresponding to a respective mounting aperture of the stator assembly, each threaded boss configured to receive a threaded fastener.

13. The power tool of claim 12, wherein the housing defines a longitudinal axis, and wherein the mounting legs are angularly spaced about the longitudinal axis at unequal intervals.

14. The power tool of claim 12, wherein the stator assembly includes a stator body having a plurality of axially extending mounting ribs projecting radially outward from the stator body, and wherein the mounting apertures are defined in the mounting ribs.

15. The power tool of claim 14, wherein each mounting leg includes a pair of projections and an alignment groove defined between the projections, and wherein a portion of each mounting rib is received into a corresponding alignment groove.

16. The power tool of claim 12, wherein the heat sink includes a plurality of mounting tabs extending outward from a periphery of the heat sink and defining fastener apertures, and wherein each fastener aperture aligns with a corresponding mounting aperture.

17. An electric motor assembly comprising:

a circuit board;

a stator assembly having a first end coupled to the circuit board and a second end opposite the first end, the stator assembly including

an annular stator body having a plurality of inwardly projecting teeth,

windings wrapped about the stator body to form a plurality of coils, and

a terminal coupled to an outer periphery of the stator body and extending longitudinally between the first end and the second end, the terminal being coupled to the circuit board at the first end and being coupled to the windings at the second end to electrically connect the windings to the circuit board; and

a heat sink coupled to the stator assembly and in thermal contact with the circuit board, the heat sink having an end wall defining a bearing pocket, and a plurality of axially extending cooling flanges extending from a periphery of the end wall;

wherein the terminal is molded to an attachment member, and the attachment member is molded to the outer periphery of the stator body.

18. The electric motor assembly of claim 17, wherein the terminal includes a central plate portion, a connecting portion extending from the central plate portion and electrically coupled to the circuit board at the first end, and a hook portion extending from the central plate portion and configured to engage the windings at the second end.

19. The electric motor assembly of claim 17, wherein each cooling flange defines an airflow aperture.

20. A power tool comprising:

a housing defining a longitudinal axis and including a rear wall;

a motor assembly coupled to the rear wall, the motor assembly including a stator assembly defining a plurality of axially extending mounting apertures; and

a plurality of mounting legs projecting from the rear wall toward the motor assembly, each mounting leg defining a threaded boss corresponding to a respective mounting aperture of the stator assembly, each threaded boss configured to receive a threaded fastener.

21. The power tool of claim 20, wherein the rear wall extends perpendicular to the longitudinal axis.

22. The power tool of claim 21, wherein the mounting legs include a first mounting leg, a second mounting leg, and a third mounting leg.

23. The power tool of claim 22, wherein a first mounting leg angle A1 is defined between the first mounting leg and the second mounting leg about the longitudinal axis, a second mounting leg angle A2 is defined between the second mounting leg and the third mounting leg about the longitudinal axis, and a third mounting leg angle A3 is defined between the third mounting leg and the first mounting leg about the longitudinal axis, and wherein $A1=A2\neq A3$.

24. The power tool of claim 20, wherein the stator assembly includes a stator body having a plurality of axially extending mounting ribs projecting radially outward from the stator body, and wherein the mounting apertures are defined in the mounting ribs.

25. The power tool of claim 24, wherein each mounting aperture aligns with a corresponding mounting leg.

26. The power tool of claim 24, further comprising:

a circuit board proximate an end of the stator assembly, the circuit board including a heat-generating component; and

a heat sink coupled to the stator assembly and in thermal contact with the circuit board, the heat sink including a plurality of mounting tabs extending outward from a periphery of the heat sink and defining fastener apertures;

wherein each fastener aperture aligns with a corresponding mounting aperture.

27. The power tool of claim **24**, wherein each mounting leg includes a pair of projections and an alignment groove defined between the projections, and wherein a portion of each mounting rib is received into a corresponding alignment groove.

28. The power tool of claim **27**, wherein each mounting leg defines a channel extending longitudinally between an opening of the threaded boss and the alignment groove, and wherein each threaded fastener extends within a corresponding channel.

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